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CHOROIDAL SCLEROSIS IN CORONARY ARTERIOSCLEROSIS

REPORT OF A CASE

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NEW YORK

During the past fifteen years many articles have been published with the object of correlating vascular lesions of the eye with diseases of the kidney and of the brain and more rarely with diseases of the heart involving the coronary arteries and associated solely with sclerosis of the choroidal vessels. Before presentation of the report of a case of choroidal sclerosis associated with coronary arteriosclerosis, several facts pertaining to this subject will be mentioned.

Arteriosclerosis is a diversified condition in which whole vessels, or parts of them, may be involved, causing degenerative lesions in their surrounding tissues as well as in various organs, including the ocular structures. The cause of the uneven distribution of these lesions of the vascular walls is unknown. In arteriosclerosis the arteries, both large and small, are primarily involved, as distinguished from arteriolar sclerosis, which affects primarily the arterioles, causing essential hypertension.

Choroidal sclerosis is due mainly to sclerotic lesions in the arteries; the veins are rarely affected. The sclerotic process produces degenerative changes in the intervascular stroma and pigment epithelium, causing exposure of the choroidal vessels. The focal sclerosis is usually caused by arteriosclerosis, syphilis, myopia, retinitis pigmentosa or a local inflammatory lesion, but sometimes the cause is idiopathic.

The retinal vessels frequently course over the degenerated choroidal areas without giving any ophthalmoscopic evidence of arteriosclerosis, indicating merely a focal choroidal sclerosis. In cases of choroidal sclerosis it is impossible to differentiate ophthalmoscopically between arteries and veins.

The histologic picture and the changes in the fundus in this condition will be considered in the case report.

Read at the regular meeting of the Section of Ophthalmology of the New York Academy of Medicine, Nov. 15, 1937.

Arteriosclerosis may exist in any of the intra-ocular vessels without clinical evidence of its presence elsewhere in the body, or it may be present elsewhere in the body without giving rise to ophthalmoscopic signs. The presence of intra-ocular sclerosis is a definite aid in confirming a diagnosis of arteriosclerosis elsewhere in the body if other clinical evidence is present, while in the absence of such evidence and with the existence of arteriosclerosis in the eye, its presence elsewhere is probable.

Lesions of the fundus in cases of arteriosclerosis may be altered by certain general conditions, such as hypertension, nephritis and diabetes. When such conditions are present, the ophthalmoscopic signs of arteriosclerosis are markedly aggravated, and a differential diagnosis is impossible without a general physical examination.

In cases of arteriosclerosis hemorrhages and transudates, due to degeneration of the vascular walls, may appear in the fundus. Even in the absence of hypertension, these changes are frequently observed.

Long [1] has classified sclerotic lesions of the arteries into several distinct groups, including the arteriolar thickening associated with hypertension, the reparative thickening following toxic and infectious injury and the type of thickening which seems to result from senile involution, independent of any known toxin, virus or heightened blood pressure. This last type is the most puzzling and is called "decrescent" by Allbutt.

Ophüls [2] stated that old age alone is not the most essential causative factor of arteriosclerosis. He based his conclusion on the fact that arteriosclerosis, which is a patchy process, occurs often in the young and is frequently absent in the old, in whom arterial changes are likely to be diffuse.

The lesions of the fundus associated with cardiac disease are observed principally in cases of congenital cardiac disease in which there is cyanosis of the retina due to a secondary polycythemia and in cases of subacute bacterial endocarditis in which septic emboli and hemorrhages appear in the retina and conjunctiva. More rarely, aortic regurgitation pulsation phenomena are observed in the retinal vessels. In cases of coronary arteriosclerosis the ocular sclerosis, if present, is an associated sclerotic lesion and is not due to the accompanying myocarditis.

Altnow [3] stated that in eighteen of twenty-six cases of cardiac disease some degree of choroidal sclerosis was visible with the ophthalmo-

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1. Long, Esmond R.: The Development of Our Knowledge of Arteriosclerosis, in Cowdry, E. V.: Arteriosclerosis, New York, The Macmillan Company, 1933, p. 19.

2. Ophüls, William: The Pathogenesis of Arteriosclerosis, in Cowdry, E. V.: Arteriosclerosis, New York, The Macmillan Company, 1933, p. 249.

3. Altnow, Hugo: Changes in the Eyeground in Vascular Diseases and in Related Conditions, Arch. Int. Med. **40**:757 (Dec.) 1927.

scope and that in all but two instances it was associated with definite retinal arteriosclerosis. On the other hand, choroidal sclerosis was absent in thirty cases in which there was definite retinal arteriosclerosis.

Yater and Wagener [4] reported on twenty-five cases of coronary sclerosis in which the diagnosis of a cardiac lesion was confirmed by autopsy. The fundi were normal in only two cases; in one other case sclerosis of the choroidal vessels only was present. In seven cases the changes in the fundi were classified as senile sclerosis of the retinal arteries; in ten they were classified as the retinal arteriosclerosis of hypertension and in five they were not classified.

I recently examined the fundi in twenty-six cases in which a diagnosis of coronary sclerosis was made in the service of Dr. Robert Halsey at the cardiac disease clinic of the New York Post-Graduate Medical School and Hospital. In only those cases in which there were definite ophthalmoscopic signs of sclerosis was the diagnosis considered positive. Electrocardiograms were made in all cases. All the patients had one or more attacks of angina. Nephritis was absent. The ages ranged from 32 to 67; six of the patients were over 60 years of age. Ten showed retinal arteriosclerosis, one presented choroidal sclerosis alone and fifteen showed no positive signs of ocular sclerosis. Hypertension was absent in all but seven cases and was apparently not the deciding clinical factor in this series.

No conclusions can be drawn from the number of cases observed, but studies will be continued in order to correlate, if possible, vascular ocular disease with coronary sclerosis.

REPORT OF CASE

History.—A. G., an American-born Jewish merchant aged 69 (April 1937), married and the father of four healthy children, had been under the care of his family physician, Dr. Henry S. Pascal, for twenty-five years.

The patient was intelligent and of a quiet disposition. He was short, slim and dark and had a large head, a barrel-shaped chest and kyphosis due to Paget's disease of thirty years' duration. An uncle on the paternal side suffered from the same disease. There was no history or signs of syphilis. The temporal veins were engorged and tortuous.

In 1920, at the age of 52, he first complained of shortness of breath and difficulty in breathing, but there was no pain in the region of the heart. Examination revealed a systolic murmur and enlargement of the heart. The urine was normal; the systolic blood pressure was 130, and the diastolic pressure, 70. The diagnosis made in 1920 was arteriosclerotic heart disease. Since then he had been constantly under the care of his physician and had never shown any signs of hypertension or renal disease. In 1926 he complained of a rectal disturbance. A mass was discovered in the rectum, which on biopsy proved to be a carcinoma. A radical

4. Yater, W. M., and Wagener, H. P.: Ophthalmoscopic Signs in Disease of the Heart, Am. J. M. Sc. **178**:105, 1929.

operation was performed, and recovery was uneventful. As his general condition did not improve, he was referred in 1927 to Dr. B. S. Oppenheimer for an examination of the heart. The diagnosis was Paget's disease, arteriosclerosis, enlargement of the heart and auricular fibrillation.

Since 1927 he had frequently visited his physician on account of difficulty in breathing. He never complained of anginal pains but had frequent attacks of edema of the eyelids and extremities, which were always relieved by the use of tincture of digitalis. His blood never showed any evidence of secondary anemia. From year to year he gradually grew weaker and the cardiac disease became more pronounced until in April 1937, when, attempting to stretch out his arms, he died. Permission was granted for a complete autopsy, including removal of the eyes. The autopsy was performed by Dr. James R. Lisa; the eyes were placed in solution of formaldehyde for future study.

Autopsy.—The immediate cause of death, which could explain its sudden character, was extremely acute degeneration of the myocardium without any evidence of acute coronary thrombosis. The arteriosclerotic changes in the body were limited in distribution but severe. The entire pulmonary arterial tree was affected by marked arteriosclerosis. Histologic examination showed calcification and fibrosis, but without associated cellular reaction. This apparently is an end-stage. The second site of arteriosclerosis was the coronary system. The superficial coronary arteries (fig. 5) were intensely sclerotic and of the pipestem type; in some areas there was narrowing of the lumen but without occlusion, either chronic or acute. There was curiously little scarring of the myocardium, and the intrinsic coronary arteries were normal. Widespread arteriosclerosis of the left auricle was present, the entire endocardium being involved, so that the inner wall resembled an egg shell, thin and friable. Histologic examination of this wall showed fibrosis of the endocardium and subendocardial areolar layer, with numerous small plaques of calcium. There was complete absence of a cellular reaction. The pulmonary veins of the neighboring area were normal. There were slight arteriosclerotic changes in the aorta. The arteries of the kidneys were normal. There was no evidence of hyperplasia of the small radicles of interlobular caliber, and the arterioles were normal. Histologic examination of the kidneys indicated that the condition was not essential hypertension. Gross examination of the brain showed perfectly normal arteries; histologic examination of these vessels was not made. The spleen showed moderate sclerosis of the central arteries quite compatible with the age period. The arteries of all the other organs were normal. The heart weighed 450 Gm.

A diagnosis was made of Paget's disease of the bone, acute myocardial degeneration and arteriosclerosis of the coronary arteries and aorta.

Ophthalmologic Examination.—The first ophthalmologic examination conducted by me was made in April 1927, and others were made at varying intervals until the patient's death. His chief complaint was poor vision. Vision in the right eye equaled 20/20 with a plus 1 diopter sphere. External examination and functional tests showed nothing abnormal. Examination revealed the fundus to be of the tessellated type, affording visibility of the choroidal vessels. The disk and retinal vessels appeared to be normal. Several grayish dots, the size of a pinhead, were localized on the temporal side in the equatorial area. There was a slight pallor in the macular area. Vision in the left eye equaled 20/200 with a plus 1 diopter sphere. External examination and functional tests gave negative results. The fundus was of the tessellated type. The disk and retinal vessels were normal. About one-half disk diameter from the disk in its temporal area could be seen a

large ill defined elliptic and partially atrophic choroidal patch with a small hemorrhage, the size of a pinhead, in its superior and temporal border. This patch had a mottled appearance; its upper border invaded the macular area, and a few normal retinal vessels traversed its surface.

After this examination the patient returned at infrequent intervals until his death. The intermediate stages of the progression of the changes in the fundi will not be described, with the exception of an incipient choroidal atrophy in the macular area of the right eye in 1930, which gradually reduced the vision to 20/200

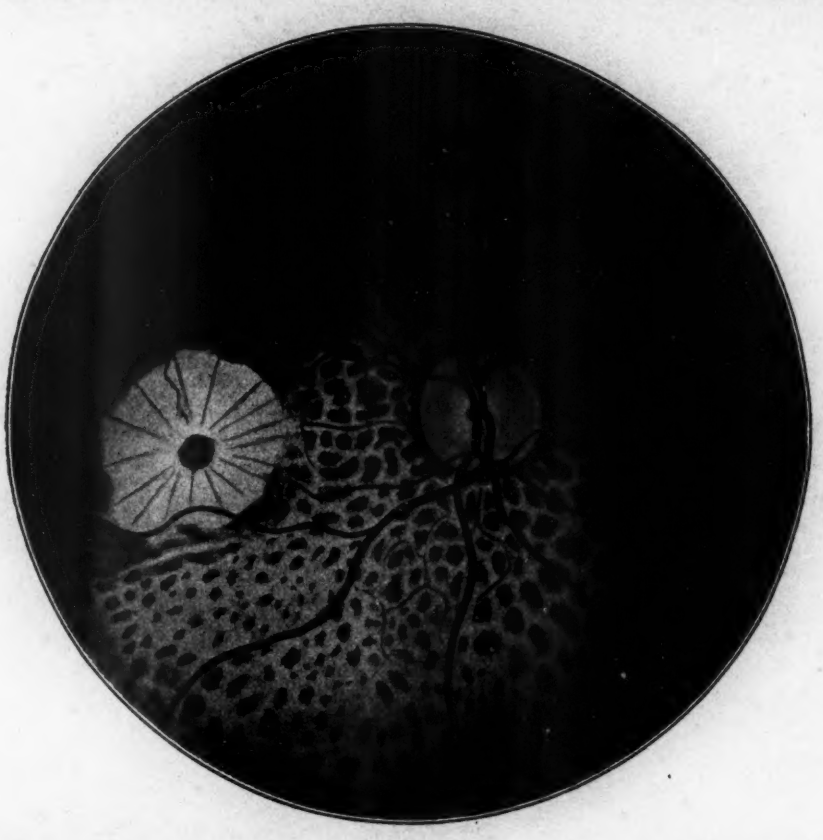

Fig. 1.—Drawing of the fundus of the left eye, showing localized choroidal sclerosis and fine canalization of some vessels.

with a lens correction. In the left eye the vision was reduced to counting of fingers. The bilateral choroidal degeneration gradually increased in all directions, but especially in the left eye, reducing the vision in each eye to perception of objects at 1 foot (30 cm.) in 1936.

A drawing of the fundus of the left eye (fig. 1) was made two months prior to the patient's death. The right eye showed a similar lesion, with the exception of the marked choroidal atrophy in the macular area. At that time the fundus of the left eye was of the tessellated type. The optic disk appeared normal, as did the retinal vessels over the entire retina, including the choroidal patch. Starting from the temporal margin of the disk, a large ill defined and atrophic choroidal patch extended downward and to the macular area. The patch had a mottled

Fig. 2.—Section of the area which clinically demonstrated choroidal sclerosis; × 120. Note the atrophy of the choroid and the relative fibrosis of the arterial walls without any marked thickening or encroachment on the lumens of the vessels.

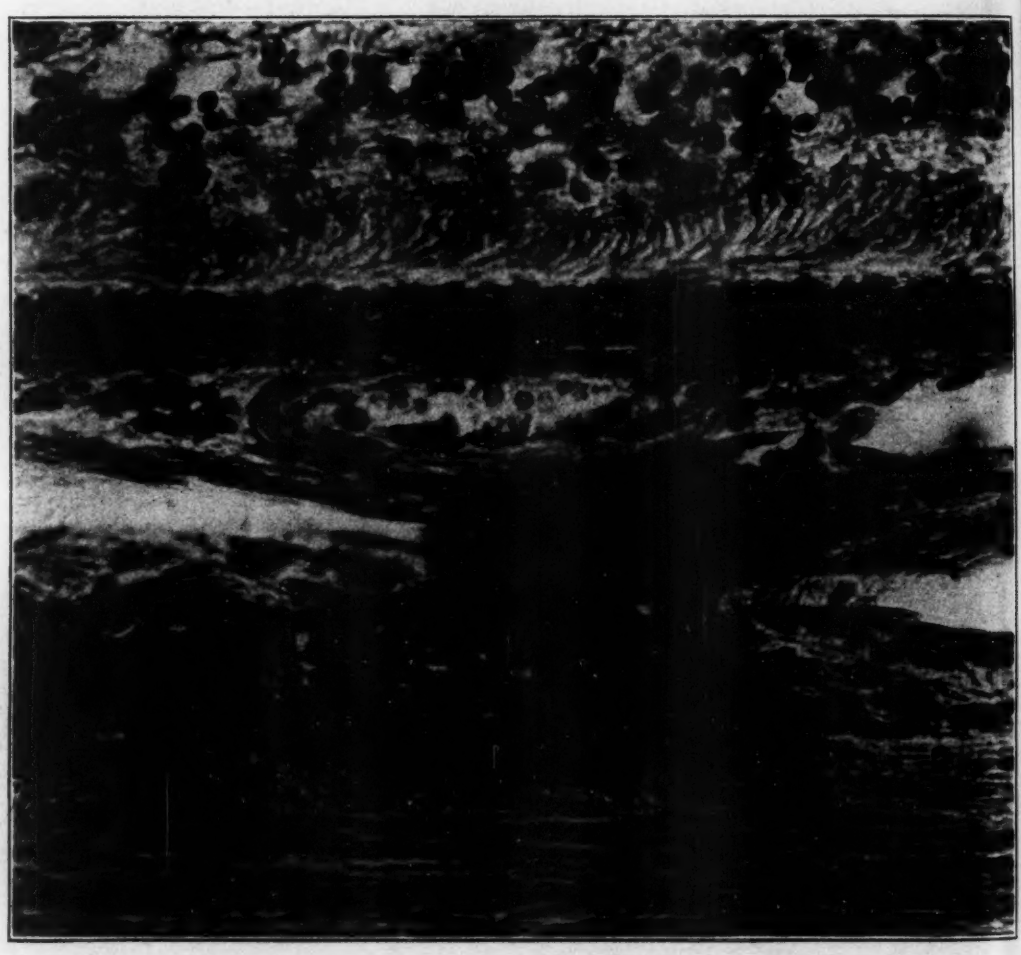

Fig. 3.—A choroidal artery seen in figure 2, showing the fibrotic wall without narrowing of its lumen; × 240.

Fig. 4.—A branch of the central retinal artery, with essentially no abnormalities in its structure; × 240.

Fig. 5.—Extensive calcification of the walls of the coronary vessels with encroachment on the lumens; × 20. The calcification is mainly confined to the media (Mönckeberg's sclerosis).

appearance due to the anastomosis of the choroidal vessels, which appeared as narrow whitish bands, in some of which a fine red line was visible in the lumen, indicating circulation, while in most of the vessels no lumen could be recognized. The intervascular stroma was slightly pigmented. In the macular region was a whitish circular area one-third larger than the disk, in the center of which was a blackish dot in the fovea, with many fine blackish lines radiating from it. The white patch was the site of an earlier large circular hemorrhage, which after a month was gradually resorbed, leaving scar tissue.

A diagnosis was made of bilateral focal choroidal sclerosis without evidence of retinal arteriosclerosis.

The ocular lesion in the left eye had been in existence for some time previous to my first examination. On the other hand, the one in the right eye developed and progressed during the period of my observation (nine years), beginning, therefore, eleven years after the first evidence of cardiac disease. From this fact it might be inferred that the choroidal sclerosis of the right eye was a condition associated with, and not independent of, the coronary sclerosis.

Histopathologic Report.—Both eyes were examined. Serial sections of the left eye were prepared and then studied with various stains. The cornea, lens and media were normal. The iris was normal in structure; the iritic arteries were thick walled but showed no degenerative changes. The retina was normal. The pigment epithelium showed on the temporal side of the retina small areas of depigmentation, beneath which the choroid was thin and atrophic. The epithelium was markedly deficient in pigment, although at the peripheries of the areas the pigment was very dense. In the areas of depigmentation (fig. 2) the intervascular stroma appeared condensed and relatively increased in amount, merging at the periphery with the more normal intervascular stroma of the adjacent areas. The walls of the arteries in the depigmented areas were somewhat changed from normal; the thickness was not altered, but the muscular coat was replaced by fibrosis, which was quite acellular (fig. 3). The elastica stained rather poorly. The endothelium was preserved. The lumen was normal. In the more normal portion of the choroid the thickness was somewhat diminished, but the arteries in these regions had a perfectly preserved pattern. The internal elastica was clear, stained sharply and was not split. The muscular coat was well preserved, and many of the muscular nuclei were quite distinct. The optic nerve was normal, as were the central artery (fig. 4) and vein and the vessels surrounding the head of the optic nerve. The arteries in the dural sheath of the nerve showed thickened walls. An occasional very small plaque of calcification was found in the sclera.

COMMENT

The only changes seen in the eyes histologically were limited to the focal area of the choroid, on the temporal side only. They consisted of depigmentation, relative fibrosis and atrophy of the choroid and sclerosis of the choroidal arteries. These changes resembled purely degenerative lesions of the muscular coats, without alteration of the thickness of the walls or encroachment on the lumens, and differed from the hyperplastic changes in the vascular walls observed in cases of essential hypertension and chronic glomerular nephritis.

Dr. Henry S. Pascal supplied me with the history of the patient.

DISCUSSION

DR. JAMES R. LISA: This case is of extraordinary interest because it is seldom that one can perform a complete autopsy and check the histologic changes in the eyes with the results of preceding ophthalmoscopic examinations. A point of interest is that the change which one would ordinarily expect to see in the eyes was not present. The most frequent change, of course, is that described by Dr. Cohen—hyperplastic change associated with hypertension or with glomerulitis. In the case reported here the lesions apparently were of the purely degenerative type, with little change in the lumens of the arteries. A second point of interest is the focal localization. There was no evidence of any inflammatory lesion in the eye. This brings up the question of the relation of inflammation to degenerative focal lesions in the eye. Any highly specialized organ is extremely susceptible to degenerative changes, and one of the most highly specialized organs, of course, is the brain. Since the eye is an outpouch it can be considered as part of the brain. Some years ago Dr. Pike, in doing some experimental work on the vascular supply of the brain, studied the changes which occurred in the neurons when the vascular supply was cut down for short periods of time, and it was shown by his work that occlusion for a few seconds would cause degenerative lesions that were visible under the microscope. This raises the question whether the moderate degenerative lesions occurring in the arteries in this case could have been the basis of the changes visible in the eye. The change in the vascular walls was fibrotic, and naturally that means a loss of elasticity. It is possible, therefore, that loss of elasticity could so interfere with the proper function, or proper nutrition, of the eye, as to lead to focal patches of sclerosis, such as those seen in this case. The relation of choroidal sclerosis to coronary arteriosclerosis is a point of interest, but one on which one cannot take a definite stand. In this case the arteriosclerosis of the coronary arteries was very intense and led to the type of cardiac dysfunction usually seen in such cases. This again illustrates the fact that sclerosis is not necessarily a generalized condition. As a matter of fact, generalized arteriosclerosis is a poor term, because it is misleading. In this case the most intense sclerosis was in the coronary arteries. The sclerosis was also intense in the pulmonary arteries, but to a less extent, and was moderate in the aorta. It was focal in the eye, and even here it was limited to a small highly specialized part. Examination of the kidneys in this case probably indicated why hypertension was not found; they were normal, with no changes in the large vessels, and the arterioles were normal.

DR. ROBERT H. HALSEY: I think that the fact should be kept in mind that when the coronary arteries are involved there may be some disturbance in other parts of the body without there necessarily being any relation between the two in the sense that because disease of the coronary artery is present there may therefore be a similar disease elsewhere in the body. In this particular case I think that it is interesting that there was such an intense coronary disease, and yet coronary thrombosis apparently did not occur, or at least it was not mentioned. I assume that it was not present. Auricular fibrillation was reported, and I think that with the swelling of the face and ankles which was present it is quite possible that there was a prolonged congestive

condition of the base of the lungs, and possibly in other parts of the body. The pulmonary circulation undoubtedly was greatly impaired. I think that this is a most interesting study that Dr. Cohen has been making of the relation, if one may say so, between coronary thrombosis and the condition of the eye. In general, I believe, he found some arteriosclerosis in the eye in about 40 per cent of cases of definite coronary thrombosis. In the other 60 per cent there was possibly no such evidence. I think that it will be interesting to continue the study and to find out the usual percentage and relation of the two conditions. I think that one should stop with stating the facts and not try to infer that a relation exists.

DR. ADOLPH POSNER: It is not clear to me what made Dr. Cohen associate the two conditions—the coronary sclerosis and the choroidal sclerosis—other than the presence of the one incidental to the other.

DR. MARTIN COHEN: I think that I stated in the paper that the condition in the right eye was observed about nine years after the symptoms of cardiac disease. The patient first showed some macular pallor, which gradually developed into evidence of sclerosis of the choroidal vessels. He was observed for eight or nine years, so that I saw him before choroidal sclerosis began. I saw him when the coronary disease had already developed and naturally would infer from that that it was an associated, and not an independent, condition. I cannot say positively that the conditions were not independent, but my inference would be that they were not.

PYRETOTHERAPY IN OPHTHALMOLOGY

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Although the therapeutic use of induced fever has attracted the eager attention of ophthalmologists, it is certain that it is far from having entered into the current domain of ophthalmology. Works treating the question are still rare, especially in French-speaking countries. Among the authors who have occupied themselves with this matter may be cited: in Belgium, J. Francois; in France, J. P. Carlotti, A. Gault, D. Paulian, S. Schiff-Wertheimer and H. Viallefont; in the United States, W. L. Benedict, G. P. Clark, A. M. Culler and W. M. Simpson, P. O'Leary and A. L. Welsh, C. Weskamp, and E. L. Whitney; in Italy, A. Ferrari, Livio-Pratti, G. Roasenda, Sabbadini, and G. Tirelli; in Rumania, L. Winkler; in Germany, C. Behr, Fischer and Ascher, B. Fleischer, Gasteiger, R. Hessberg, Igersheimer, E. Weinberg, and J. Wolff, in Austria, Wagner-Jauregg, and in Japan, K. Ohyama.

Before indicating the pyretogenic processes that are made use of in ocular therapeutics, with the results that one can obtain, it is necessary to insist on the essential difference which exists between pyretotherapy and the therapeutics of shock, especially because the two methods are often mistaken for one another and one often hears that the therapeutics of shock is particularly employed in ophthalmology. In fact, the great majority of ophthalmologists—I would almost say all—have recourse to medication by shock. The methods are varied; the one most employed is, without doubt, parenteral injection of milk. Certainly, in many instances shock is accompanied by thermal modifications and is therefore more or less pyretotherapeutic. But shock has three characteristics: collapse of the nervous system, arterial hypotension and leukopenia. Moreover, in the patients in whom one has caused shock one always notices sudden modifications of the blood plasma, and incoagulability of the blood. These do not occur in the patient treated by pyretotherapy, for whom hyperthermia is especially sought. Pyretotherapy is treatment by fever. The fever brings modifications in the organism which are capable of bringing about the cure of the malady. It cures by its simple existence, either by making the habitual therapeutic agents more active or by causing the organism to

Read at the meeting of the First International Conference on Fever Therapy, New York, March 30, 1937.

be more receptive to these agents. With a great deal of reason, C. Richet and A. Meyer-Heine said: "Shock is one thing; pyretotherapy is another." Besides, therapeutic shock can bring about an appreciable result without being accompanied by the slightest increase of temperature, and often there is a difference between the thermal reaction and the therapeutic effect.

The principal pyretogenic agents employed in ophthalmology are: malariotherapy, dmelcos, pyrifer, sulfur in oil, the Kettering hypertherm and short waves.

I. MALARIOTHERAPY

The excellent results obtained by inoculation with the organisms of malaria in cases of dementia paralytica necessarily inclined ophthalmologists to try it in cases of syphilitic disease of the eye, particularly of atrophy of the optic nerve.

From a practical point of view, it may be recalled that one should always be careful to inoculate Plasmodium vivax, the parasite of benign tertian ague, and not Plasmodium falciparum or the parasite of the quartan fever, which might cause serious or even fatal accidents.

The donor should not be a native of a paludal or colonial region. One can well make use of a stock that has been tested and that one can transmit from one patient to another.

One takes from the bend of the elbow a sufficient quantity of blood to be injected, an average of 3 cc. For this purpose one uses a needle mounted on a syringe. It is not necessary to take the blood at the time of the acme of a febrile attack. The method of inoculation is generally the subcutaneous one. After the blood is in the syringe, one injects it, with the same needle, under the skin at the level of the subscapular region of the abdomen, at no matter what site. Certain authors, among them Rademaeckers, Rodríguez Arias and Paulian, prefer the intravenous method, as they believe that it is more sure, and with this method the period of incubation is shorter. The period of incubation generally passes without incident. It lasts from eight to twelve days after inoculation by the subcutaneous method and from six to eight days when one has made use of the intravenous method. It is also necessary to know that it is shorter in summer, especially at the commencement of this season, and that it is longer at the end of autumn and in winter.

The evolution of paludism is variable. The termal oscillations are at first irregular. After three or four days they become more regular. The temperature then attains 40.5 C. (105 F.) or even 41 C. (106 F.) and drops to 37 C. (98.6 F.) when the attack has passed.

During the period of the attack it is necessary to watch the patient attentively. One takes the temperature three times a day; one must

watch the pulse rate and the arterial pressure and must note the amount of urine, marked oliguria necessitating suspension of the attacks.

On an average, one allows eight or ten attacks to develop. In reality, this number is variable; it depends on the age of the subject, on his tolerance and on his previous condition. With feeble persons one can carry out the treatment in two series. In that case one stops the treatment after four attacks, reinoculates with malaria at the end of a month and stops the treatment again after four more febrile attacks.

One interrupts the attacks by giving, during three or four days, 1.5 Gm. of quinine sulfate, in three doses. The action of the quinine is evident; all the authors have agreed that quinine is much more active in provoked malaria than in malaria resulting from the bite of a mosquito.

The accidents from the methods should be known. Some authors have mentioned mortal accidents in from 3 to 5 per cent of the cases. P. Savy expressed the belief that malariotherapy causes, on an average, a mortality of 10 per cent. Cardiac collapse represents the most serious complication. It may occur in the course of a hyperthermic crisis, or it may develop suddenly or progressively outside the state of hyperthermia. This explains how important it is to watch the pulse rate and the arterial tension. A maximum tension of 9 should cause one to stop the treatment immediately. As major accidents it is necessary to mention acute hepatic deficiency accompanied by serious icterus, hemorrhagiparous syndromes (hemorrhages affecting the kidneys, the intestines or the brain), and rupture of the spleen, always fatal. As benign accidents may be mentioned cutaneous lesions, in particular herpes, the frequency of which is still much debated.

The enumeration of these complications permits of establishing the conditions necessary in treatment with malaria. A relatively good general condition, no grave impairment of circulation and absence of damage to the kidneys and liver are required. Pulmonary tuberculosis constitutes a strict contraindication, as do marked arterial hypotension, obesity in a patient with a large heart, cardiac decompensation and aortic aneurysm. Let me say again that it is necessary to be doubly prudent in cases of extrasystole, of permanent arrhythmia, of hypertension and of contraction of the mitral valve, because these are conditions in which the patient is always exposed to danger. It is recommended that patients who have passed their sixtieth year should not be inoculated.

Many authors are of the opinion that malarial inoculation can be utilized during pregnancy. In general, it would not cause miscarriage. The child may live if its paludism is treated as soon as it is born.

The treatment should be carried out in an institution or in a hospital. There it would be possible to establish the indispensable observation and immediately apply the necessary treatment if the slightest complication supervened. Sojourn at an institution is also indicated from a

social point of view, because it has been proved that a patient inoculated with malaria can infect anopheles that would transmit the malaria.

It is also necessary to know that malariotherapy is a most depressing treatment. Vomiting often accompanies febrile attacks. Nearly always there is anorexia, which may be complete. Therefore, great fatigue and marked wasting away will result from the treatment.

Among the first ophthalmologists to treat syphilitic atrophy of the optic nerve with malaria one must mention de Behr and Henson. Their example has been quickly followed by others. But if one studies the results which have been published, one is struck by the little agreement that one finds. Some authors have proclaimed that the method is marvelous and that it will bring about real amelioration. Some have expressed the opinion that it succeeds only in stabilizing the illness. Finally, others have condemned it, saying that it is dangerous and that it may result in grave catastrophes.

In order to be able to have a more or less exact idea of the value of malariotherapy in cases of syphilitic atrophy of the optic nerve I have divided into three groups the various authors who, to my knowledge, have occupied themselves with the question, according to whether they have observed amelioration, maintenance of the status quo or aggravation.

In the first group, among those who have seen improvement resulting from this treatment are: Fischer and Ascher, who observed amelioration in one of eighteen cases; Artwisky and Ostrewski, who noted amelioration in one of nine cases, and Sabbadini, who observed it in three of six cases in six years. Carlo Goria, Leroy, Medakovitch and Prieur also declared that the visual keenness may be heightened. Lassale, Sonier and Anjalu have seen vision become better in one case. Wagner-Jauregg also spoke of a slight improvement in vision. D. Paulian saw improvement in two of twenty-nine cases. G. P. Clark, who studied fifty patients with dementia paralytica, stated that the visual acuteness improved in thirteen. Fleischer has also noted that vision improved. Charles Weskamp has observed amelioration in eight of sixteen cases.

In the second group I include all those who have noted stabilization, or maintenance, of vision after this form of treatment. It is fitting to cite here all those who have reported amelioration, for in their works they have mentioned also patients whose vision has been stabilized. Thus, Fischer and Ascher pointed out that in their eighteen cases the vision existing before the treatment was preserved, and Paulian considered that in half the cases observed by him the evolution of the ocular condition was stopped. Fleischer mentioned eight cases in which visual acuteness had been stabilized, one of which he had observed for eight years. Wild Margareth noted arrest of the atrophy of the

optic nerve in four of five cases, Wolff in five of twelve cases and Marinesco in five of ten cases. Suzanne Schiff-Wertheimer stated that Arruga declared that he had noted stabilization of the ocular condition in two of six patients. J. Chaillous noted maintenance of vision during five years in three cases and during two years in one case. Pensitur and Orzechewski have also ascertained that one can check the atrophy of the optic nerve. Heinsius mentioned a patient who had been treated during the previous eight years and in whom the ocular condition remained stationary.

In the third group, which consists of the adversaries, may be cited C. Behr, who deems that the method is a bad one. Igersheimer, Beyer, Kehrer and Rimge have shared the same view and have insisted on the dangers of this treatment for vision. O'Leary stated that he saw aggravations in seven of nine cases. Gasteiger said that he saw visual acuity diminish in fifteen of twenty-one cases, and in eight of these the lowering of vision was particularly rapid, occurring immediately after the treatment. He expressed the opinion that malariotherapy should be abandoned in view of the possibility and even the probability of detriment to the patient.

What conclusions can be drawn from all these observations?

It may be stated first that all the adversaries of malariotherapy in cases of optic atrophy, those who judge that it is a dangerous technic which causes aggravations, are in the minority in comparison with those who praise its effects. It is true that one is always more inclined to describe the happy results of a new therapy than to describe the failures. It would therefore seem that in a great number of cases the introduction of the malaria organisms stabilized the condition. I shall not speak of improvement. If there is any, all the better.

To bring about this stabilization it is absolutely necessary to treat the disease at the beginning. That is a point on which one cannot insist enough. Wagner-Jauregg also recommended attenuated malarialization, so that the temperature will not go higher than 40 C. (104 F.), because high pyrexia may have a bad influence on the optic nerve. In this respect he is an advocate of the process of Horn and Kauders, who administer 0.05 Gm. of quinine every two days during the period of incubation and the same dose every day as soon as the attacks are established. But Suzanne Schiff-Wertheimer has expressed doubt whether the prolonged use of quinine, even in small doses, might not interfere with the circulation of the optic nerve, the more so because the nerve is ill. She therefore insisted that the ophthalmoscopic examination be made so as to show the papillary vessels. Creuzon, however, does not think that the quinine treatment can have an influence on the optic nerve, for the good reason that he has never met with ocular complications in patients given small doses of quinine.

The treatment appears to succeed better if other therapeutic means have not been previously tried, and malariotherapy should be followed by chemotherapy. One month and a half after inoculation with the organisms of paludism one commences antisyphilitic treatment, generally on a basis of arsenic, with bismuth. Even mercury has been employed. Chemotherapy should always be prolonged.

All the authors are agreed that dementia paralytica benefits much more from the malariotherapy than tabes does. This must explain the improvement obtained in an impressive proportion of cases of atrophy of the optic nerve that one learns of from certain statistics. G. P. Clark, as I have already said, mentioned improvement in thirteen of fifty cases. But these were cases of dementia paralytica. The same is true for pupillary signs. Among these fifty cases of dementia paralytica, Clark noted disappearance of bilateral Argyll Robertson's sign in twenty-two and disappearance of unilateral Argyll Robertson's sign in six. Among seventy-two patients with dementia paralytica with fixed pupils who were subjected to malariotherapy, K. Ohyama noted ten in whom the photomotor reflex was reestablished, while it is admitted that the pupillary symptoms of tabes are rarely modified by the malaria treatment. One must, however, mention that Leroy, Medakovitch and Prieur have seen reappearance of the photomotor reflex after malaria treatment has been given to a patient with tabes.

Inoculation with malaria organisms has been applied also in the treatment of parenchymatous keratitis—in smaller numbers of cases, it is true, because it is recommended that it not be used for children under 12 years of age. In children below that age attacks of paludism are badly tolerated.

J. Ambler and J. Van Cleve praised the results of malaria therapy in this condition, which are superior to those obtained by the ordinary antisyphilitic treatments. They stressed particularly the rapid disappearance of pain, weeping and photophobia and the resorption of the corneal opacities. Among seventeen cases, the injury remained unilateral in five.

But Irena Mrazova has been less enthusiastic. This author expressed the opinion that even if the subjective and objective signs diminish they reappear later, with greater intensity. Among twelve cases, improvement was evident in only two. Recurrences were not avoided, and the prophylactic effect was nil.

Kuborn treated four patients; it was not possible for him to express an opinion.

II. DMELCOS

Inaugurated in 1928 by Sicard, Hagueneau and Wallich as a pyretogenic agent, the antichancroidal vaccine of Nicolle, called dmelcos, is a stabilized emulsion of the Ducrey bacilli from several stocks, at a titer of 225 million micro-organisms per cubic centimeter. It is dis-

tributed in ampules containing 225, 335, 450, 550 or 675 million bacilli. It is injected by the intravenous method, and the dose varies. It is necessary that a sufficiently high temperature be attained; it should rise to from 39 to 40 C. (102 to 104 F.). "One must not employ," wrote Milian, "too feeble doses or leave too long intervals between the injections." It is recommended that one commence with extreme prudence, by injecting 0.5 cc.. This dose often causes sufficient elevation of temperature. If it does not, one may progressively increase the dose 0.5 cc. at a time, up to 4 or 5 cc. if necessary. When the optimum dose is reached, one stops. There is no reason for increasing the dose when the thermal elevation is sufficient. It sometimes happens that the reaction diminishes with later injections. It is then necessary to use stronger doses, always increasing the amount by 0.5 cc. at a time. The contrary may also happen. In these circumstances it is evident that one must diminish the quantity.

According to Sicard, one may give two or three injections a week. The injection may be repeated up to eighteen or twenty times. The period of incubation is about the same for each patient. Generally, two or three hours after the injection the patient suffers from a general feeling of discomfort, with a sensation of cold. At the same time intense shivering starts, which is of the pseudomalarial type. The shivering may be accompanied by nausea and vomiting. It is sometimes painful. The temperature increases at the same time up to 39 or 40 C. The pulse is accelerated, but the arterial tension is not lowered. The increase of temperature attains its acme at the end of five or six hours. A sudoral attack then comes on, and the temperature rapidly drops. In every case the temperature always becomes normal the following day.

The great advantage of dmelcos is that it is easy to administer and permits of provoking fever at will. It is generally well tolerated and does not lead to anorexia or violent shock.

It is, however, recommended that it should not be used for elderly persons, tuberculous persons, persons with cardiac or nephritic conditions or patients who suffer from phlebitis or aneurysm. In fact, these conditions are the general contraindications to all pyretotherapeutic methods.

In cases of syphilis is is necessary to combine the antisyphilitic treatment with dmelcos. To this end several authors have used sulfarsphenamine or tryparsamide, which they injected by the intravenous method immediately after injection of the antichancroidal vaccine.

Among the first essays on dmelcos therapy in ophthalmology, one must mention a work by H. Viallefont, who in 1928 applied the method with success in a case of traumatic keratitis complicated by iritis. The patient was nonsyphilitic; acetylsalicylic acid and sodium salicylate had

been of no use. The second day after only one injection, which caused the temperature to go up to 39 C., the patient went back to work, with a normal eye.

Carlotti has used dmelcos for different disorders. Often he has given it in association with propidon (a mixed stock vaccine prepared by the method of P. Delbet) which he injects first. Sometimes he has followed the injection of dmelcos by an injection of sulfur in oil. He uses thus, as he said, the whole pyretogenic scale, not confining himself to one product. He leaves an interval of two days between the injection of propidon and that of dmelcos, and four days between the consecutive injections of sulfur in oil.

He has treated numerous patients with trachoma by this method. In cases in which the disease was acute, this author wrote, pyretotherapy has acted effectively, and in cases in which there were complications its help not only has been certain but appears to be preponderant.

This author has also noted good effects in cases of conjunctivitis caused by the bacillus of Weeks and by that of Morax, as well as in those in which the disease was due to the gonococcus. It is in this condition that he believes that he has obtained the best results. He mentioned a case of gonococcic conjunctivitis in a patient of 25 years, who was completely cured, without any local treatment, after injections of propidon and of dmelcos.

The corneal ulcers treated by Carlotti were also benefited by this method. The pain disappears first.

He also praised dmelcos for the results obtained in cases of interstitial keratitis, in which the infiltration has always been remarkably influenced by this agent. He has never seen the second eye encroached on during pyretotherapeutic treatment.

Magitot was willing to give statistics concerning twenty-six patients whom he treated by means of the antichancroidal vaccine of Nicolle. In fifteen of these patients he injected only dmelcos, in addition to the local treatment, and in the other eleven he combined this treatment with injections of milk, of propidon and of sodium hyposulfite.

Among the patients who were treated only with dmelcos, there were one with an infected dermoid cyst, one with neuroretinitis of unknown cause, one with follicular conjunctivitis associated with grave adenopathy, five with iritis and iridocyclitis, two with postoperative infections and five with keratitis.

Dmelcos gave a marked result in the case of the infected dermoid cyst. It had no effect on the neuroretinitis or on the conjunctivitis associated with adenopathy. In four of the five patients with iritis and

iridocyclitis the conditions were happily influenced, as were the postoperative infections, and the keratitis, in three of the five patients with this condition.

These statistics demonstrate that dmelcos therapy is particularly useful in cases of iritis, iridocyclitis and postoperative infections. The same conclusion has been drawn from the results in cases in which injections of dmelcos have been combined with those of milk, of propidon and of sodium hyposulfite.

Mention may also be made of the observations of A. Gault in two cases of spasm of the central artery of the retina, which yielded to treatment with injections of dmelcos combined with injections of acetylcholine hydrochloride when treatment with the vasodilator alone had given no result.

III. PYRIFER

This produce is a nonspecific protein mixture prepared with extracts of fever-producing bacteria drawn from certain nonpathogenic stocks. There exist diverse degrees of activity (1 to 7), corresponding to a strength of from 50 to 5,000 million organisms per cubic centimeter.

The preparation is administered by the intravenous method, at the rate of one injection every two or three days. One begins with one injection of 1 cc. of pyrifer of degree 1 activity. Then one increases the dose so that each time the temperature reaches from 39 to 40 C. For the first injections one increases the amount generally from the single to the double dose. When the larger doses, those of pyrifer of degree 4 activity and greater are reached, one progresses more slowly, giving about a third more of the amount previously injected. But all that is in theory. The progression should above all be made according to the reaction of the patient. Some patients have a high elevation of temperature after a weak dose. In these circumstances the rate of progression should be moderate. One important fact to know is that one must never make a fresh injection until the temperature has returned to normal. If for one reason or another it is necessary to interrupt the treatment for more than five days, one must begin again with a weaker dose than the last one given. One generally gives twelve injections. The treatment may be tried for elderly persons. One may give the treatment to persons who are going about, but there must be medical supervision.

Among the ophthalmologists who have made use of pyrifer may be mentioned G. V. Volkmann, Hessberg, J. Wolff, Kehrer, Kumbruck and Kramer.

Again attention must be drawn to cases in which it has been possible to check syphilitic atrophy of the optic nerve as there are cases in which the treatment has been without result. Kumbruck noted check of the atrophy in two of three cases.

Kramer applied the method for eleven patients suffering from parenchymatous keratitis. In seven cases the complaint remained unilateral. In four eyes the condition was cured, with vision of 1.

Kehrer abandoned pyrifer, from which he never had the slightest favorable result.

IV. SULFUR IN OIL

Let it be recalled first of all that sulfur in oil has been applied in the treatment of dementia paralytica for the last ten years. The first trials were made by Knud Schroeder, of Copenhagen, who observed cure in five of fourteen cases. His example was followed by others, who applied the method not only in cases of dementia paralytica but in many cases of syphilitic or nonsyphilitic disorders of the nervous system.

One generally employs a suspension of sulfur. Concentrations of 1:100 and 2:100 may be used. One commences by a trial dose of 1 cc. at a concentration of 1:100, which is increased if the temperature obtained is not sufficient, for it must reach about 40 C. The increase in dose is 1 cc. at a time. It is exceptional if it is necessary to increase it to more than 3 cc. One must be careful to heat the ampule first and to shake it well so as to obtain a perfect mixture. The injection should be strictly intramuscular, and it is recommended that it be given very slowly. The maximum temperature is obtained at the end of from eight to twelve hours. One generally notes a veritable febrile bell-shaped curve, the temperature reaching 40 or 40.5 C. The acme passed, the thermal reaction is followed immediately by a return to the normal temperature in twenty-four hours. As soon as the temperature has dropped, one makes a fresh injection, or one can wait two or several days. In that way one can make from one to three series of injections, consisting of from eight to ten injections each.

The product is well tolerated. Often there is more or less marked tenderness, with redness of the skin, around the center of the site of injection. Even severe pain radiating in the thigh has been remarked. In order to lessen these pains Renard and J. François inject, at the same time as the suspension of sulfur, an equal quantity of procaine hydrochloride in a concentration of 1:100 or 2:100. There are, moreover, a suspension of sulfur in oil to which anesthetics have been added and also a preparation containing anesthetics with a solution of sulfur in oil.

General accidents are exceptional. However, the patient sometimes suffers from nausea. P. Chauvillon has noted diarrheal stools and in one instance a purpuric exanthem of the legs. If the patient shows signs of fatigue during the treatment or gets thin, the therapy should be interrupted.

Ophthalmologists have had recourse to sulfopyretotherapy for a great number of complaints. They have used it not only for syphilitic

lesions but for many maladies which do not in any way come from syphilis.

L. Winkler, Weinberg, Roasenda, Tirelli, A. Ferrari, Livio-Pratti, Busacca, Kallmann, J. Fried and J. Smith have described the results which they have obtained in cases of syphilitic atrophy of the optic nerve. They all have reported success. Winkler ascertained notable improvement of the sight in three of five cases. Tirelli observed successful results in the same proportion of cases. Ferrari, as well as Livio-Pratti, mentioned good results. Busacca cited four cases in which central and peripheral vision had been improved. Kallmann mentioned two cases of atrophy of the optic nerve in which the condition was checked. Fried has seen remission in six of twelve cases, and Smith noted one case in which the status quo had been maintained. Also, Dreyfus gained the impression that the improvement is more marked in cases of tabes with an optic commencement.

The greater number of these authors combine chemotherapy with the sulfur treatment, principally having recourse to bismuth or mercury preparations, which they inject at the same time as the sulfur preparation or in the following days. L. Winkler utilizes an emulsion of bismuth subsalicylate in a concentration of 10: 100 combined with oil containing sulfur. Roasenda makes an injection of mercury salicylarsenate the following day and an injection of a suspension of bismuth hydroxide in olive oil the day after that. Busacca also combines bismuth, and Livio-Pratti, bismuth and mercury. And they all deem that it is absolutely necessary that the intervention be energetic and early.

Several times hyperemia of the papilla has been noticed after the injections of sulfur in oil. This hyperemia is often accompanied by diminution of vision, which is only passing and which is followed by improvement. This papillary hyperemia has caused it to be said that the sulfur acts as a local stimulant of the nervous regeneration. L. Winkler, as well as Busacca, expressed the opinion that the sulfur has a specific chemical influence on the degeneration of the optic nerve.

Among the syphilitic conditions which are benefited by the sulfur therapy, one must mention parenchymatous keratitis. Knud Schroeder treated four patients with this condition. In all of them the result was particularly happy. L. W. Harrison, in two cases, obtained the same result.

Syphilitic choroiditis, as well as internal ophthalmoplegia, can also be favorably influenced by this treatment. Schroeder has seen the pupillary inertia reduced in a case of tabes. J. François related having observed after a few injections disappearance of the paralysis of accommodation and reestablishment of equal and normal pupils, which reacted to light, in accommodation and in convergence. Regular antisyphilitic treatment had had no effect.

François has also told me of an observation, not published, of arachnoiditis of the optic chiasma, probably of syphilitic origin, for which a suspension of sulfur in oil proved of real utility:

A patient 29 years of age on Aug. 1, 1933, two years after the appearance of an ulcer, showed papillary stasis in the right eye and edema of the papilla in the left eye. Vision of the right eye was reduced to perception of movements of the hand, and that of the left eye was 1. Neurologic examination gave negative results. A roentgenogram of the cranium showed signs of old compression. Lumbar puncture was made. The spinal fluid pressure was 30 cm. with the patient sitting down. The spinal fluid contained 50 cg. of albumin per hundred cubic centimeters and 35 cells per cubic millimeter, 95 per cent of which were lymphocytes; the Bordet-Wassermann reaction was negative. Examination of the urine showed neither sugar nor albumin. The Bordet-Wassermann reaction of the blood was negative. Mercury cyanide was given subcutaneously. On August 6 vision was nil on the right and the same as previously on the left. On August 15 the condition was aggravated. On August 17 when decompressive trepanation was performed (by Dr. Demoor), the brain did not appear to be compressed. A right ventricular puncture was made. The intervention did not bring about any improvement. Injections of a bismuth preparation and of hypertonic dextrose solution were made. On September 5 papillary edema with beginning atrophy of the optic nerve was seen on the right, and papillary stasis was marked on the left. On September 14 another fresh intervention was undertaken. Exploration of the chiasmic region (by Drs. Martin and Demoor) showed the subarachnoid space partitioned with numerous adhesions to the dura mater and an accumulation of fluid. The optic nerves were double their normal size. The optic sheaths were incised for a length of 5 mm. The next day there was almost complete disappearance of the papillary stasis on each side. On October 27 vision of the right eye was nil; that of the left eye was ability to count fingers at 4 meters, and the visual field was practically complete. Injections of a bismuth and of a strychnine preparation were made. In November the left optic nerve showed progression toward atrophy, and vision was reduced to ability to count fingers at 2 meters. In December 1935 and in January 1936, ten injections of a suspension of sulfur in oil were made. After this treatment vision improved, that in the left eye becoming 1/3 at the end of February. In April fresh treatment with a suspension of sulfur in oil was followed by further improvement. In February 1937 the right eye showed complete atrophy of the optic nerve, and the left eye had vision equal to 2/3, feeble. On the left side there was a pale papilla of atrophied aspect; the field of vision was practically complete.

In regard to nonsyphilitic complaints for which injections of sulfur in oil are useful, A. Ferrari cited episcleritis, scleritis, iritis and corneal infiltrations. The result would be especially brilliant in cases of postoperative iridocyclitis. In glaucoma, sulfopyretotherapy is of no use.

V. HYPERTHERM OF KETTERING

The air-conditioned chamber called the Kettering hypertherm permits of obtaining a rapid increase of the patient's temperature and maintaining it as long as one wishes. In less than an hour one can increase the rectal temperature to 40.5 C. By means of currents of

cold air one can bring it back to normal in from thirty to forty minutes. This chamber is, in fact, a hot air cabin well regulated from the point of view of the temperature of the air, of the relative humidity and of currents of air. It is rectangular and has a length of 2 meters, a height of 75 cm. and a width of 90 cm. It is divided into two parts; one is the chamber destined for the patient and the other, which is smaller, contains the mechanism which is used for heating and humidifying the air and causing it to circulate. The ceiling is double. The anterior part of its interior layer is pierced with holes, through which the hot, humid air can penetrate into the compartment where the patient is. The flooring also is double. Its interior layer forms a rolling bed recovered by an air mattress that can be pushed into the interior of the cabin or drawn outside. The extremity of the bed is outside the chamber. It is a plank on which the head of the patient rests. At the side of this plank is a vertical panel that closes the chamber hermetically and that can be instantly raised, which permits the patient's being brought out in less than five seconds. The lower part of the panel has an opening to allow the neck to pass. This opening is closed with sponge rubber, which is covered with toweling to prevent the air from escaping. A pipe placed on each side of the plank allows for the running off of the excess sweat. The mechanism is comprised of an apparatus of three units for heating the air and two electric elements which heat a basin containing water. The hot, humid air is projected by a bellows between the two layers of the ceiling and passes from there through the holes into the interior layer and into the compartment where the patient is. The air circulates around the patient and then returns into the generating apparatus. On each side of the apparatus are sliding panels which permit verifying the rectal temperature, watching the blood pressure, noting the pulse rate and observing the skin.

A temperature of from 41 to 42 C. (106 to 108 F.) is necessary. The duration of the treatment varies from five to eight hours. It has been as long as ten hours. In saying five, eight or ten hours, one counts only the hours of fever. One must therefore add the time necessary for the rise of the temperature and for its return to normal, which represents about two additional hours. In short, one must count from seven to twelve hours for the seance. On an average, one gives five sessions at intervals of twenty-four hours. Sometimes one gives eight.

Generally the treatment is tolerated well if the patient is watched by a nurse used to the method. The nurse cannot leave for an instant. As the temperature increases, the patient perspires more and more. To avoid loss of weight and great weakness he has to drink during the session from 2 to 5 liters of an iced 0.6:100 solution of sodium chloride. If the taste is unpleasant, pure water is given alternately with the solution of sodium chloride. The patient must be fasting while given the

treatment. No nourishment is allowed as long as he is in the pyretogenic chamber; but as soon as the session is finished, he is given as much milk as he can take, and he is advised to take as much as possible during the following hours.

The complications of the treatment are of small importance. One meets with erythema, bullous eruptions of the skin and labial herpes. These lesions diminish as the sessions are repeated. Often there is cephalea. One also meets with nausea and vomiting; they are especially noticed in patients who have not been fasting. Another complication—exceptional, it is true—is muscular tetany of the hands and the feet or even of the abdominal wall. This tetany can be made to disappear by means of the inhalation of nitrogen protoxide (a mixture of a 5:100 concentration of protoxide and a 95:100 concentration of ogygen) and by intravenous injection of calcium gluconate.

As contraindications one must mention advanced age, organic injury of the heart at all ages and cardiovascular alteration. The effects in cases of renal injuries are in general less harmful. Pulmonary tuberculosis is not a contraindication, but the respiratory insufficiency which results from it might prevent a sufficient increase of the temperature or the maintenance of a high temperature long enough to be efficacious (Desjardins, Stuhler and Popp).

The important work of Arthur M. Culler and Walter M. Simpson gives an idea of the value of the Kettering hypertherm in ocular therapeutics. In their report on artificial fever therapy in cases of ocular syphilis these authors related their observations on fifty-eight patients all having attacks of syphilitic complaints of the eyes.

As a technic they give ten sessions of hyperpyrexia at the rate of one per week, during which the patient is subjected for five hours to a temperature of from 40.5 to 41 C. They combine chemotherapy with hyperpyrexia, making thirty weekly injections of 0.2 Gm. of bismarsen (bismuth arsphenamine sulfonate), the first ten being given before the sessions of pyretotherapy are begun.

The fifty-eight patients who were thus treated were suffering from external ophthalmoplegia, parenchymatous keratitis, exudative uveitis, optic neuritis, neuroretinitis, choroiditis or atrophy of the optic nerve.

External Ophthalmoplegia.—Four cases were observed. Two of these were cases of recent involvement; in these improvement occurred.

Parenchymatous Keratitis.—Eleven patients were seen, ten of whom had received previous treatment. All these patients have attained vision greater than 1/5; eighteen have attained vision of 1/2 or more, and only one showed a recurrence during a period of thirty months, while previously during a period of two years he had had four recurrences. The opaque central disk of plastic exudate, which is the alarming sign of the malady, clears up well with this therapy.

Exudative Uveitis.—Ten cases were observed, in six of which the condition had occurred during the course of antisyphilitic treatment. In two cases it had been resistant to treatment with typhoid vaccine. Regularly, after the first or the second session diminution of the exudate, of the pain and of the photophobia was noticed and at the same time mydriasis was obtained.

Neuritis and Neuroretinitis.—Fourteen cases were observed, in two of which there were manifestations of secondary syphilis and in eight syphilis of the central nervous system. All the patients except two had been subjected previously to intensive treatment. After the hyperpyrexia treatment all had attained vision of 1/2 or more, although in eight papillary paleness and slight contraction of the fields of vision remained.

Choroiditis.—Seven cases were observed. In all the condition had started, reappeared or progressed during antisyphilitic treatment. Treatment with the Kettering hypertherm brought about improvement in all.

Atrophy of the Optic Nerve.—Sixteen patients were seen. All except one had been treated previously. Vision and the fields of vision remained practically unchanged. The authors added: "If atrophy of the optic nerve is associated with foci of active infiltration along the optic tract, it is probable that such exudative lesions will respond to fever therapy."

Other Conditions.—Culler and Simpson brought about equalization of the pupils in three cases of the Argyll Robertson sign with anisocoria; in two of these cases there was some recuperation of the photomotor reflex.

Comment.—The results obtained by Culler and Simpson are interesting. It would seem that it is in cases of exudative uveitis that the treatment is particularly successful. That is also the opinion of William L. Benedict, who said that the best effects are obtained in ocular conditions accompanied by cellular infiltration, such as uveitis and keratitis. According to the same author, the duration of photophobia in interstitial keratitis is reduced by half and the corneal infiltration is less intense when one combines pyretotherapy with chemotherapy. The first attack responds better to the treatment than the successive ones.

VI. SHORT WAVES

I shall be fairly brief on the subject of short wave therapy, for the good reason that the observations on ocular diseases treated by short waves as producers of artificial fever are excessively rare.

The short waves are the hertzian waves nearest to the infra-red rays. They are between 50 and 10 meters in length.

There exist two main modalities of applying the short waves: (1) utilization of the vibratory action without an increase of the temperature and (2) local and general ultradiathermy.

It is evident that this therapy is only ultradiathermy generalized in pyretotherapy. It is electropyrexia. To this end the most useful waves are those of from 15 to 25 meters in length. Apparatus are required that generate current of high frequency which provokes the creation of an intense electric field, in which one places the patient. It

is no longer necessary to apply electrodes to the body of the patient. That is one of the great advantages of the method over diathermy, because there is no danger of burning. On the other hand, the heating is augmented in depth, while diminishing at the level of the tegument. The temperature increases rapidly. With apparatus for coupling by induction, as Leroy has indicated, one produces a temperature of 40 C. in a patient weighing 70 Kg. in half an hour. After this temperature is reached, it is maintained, owing to the slowing down of the apparatus, for four hours.

Electropyrexia demands rigorous supervision by a nurse-technician during the application and the repose which must follow. In general, there is no accident to be feared. Among the important contraindications may be mentioned cardiac decompensation, marked hypotension, tuberculosis in evolution and diabetes. The method also must not be applied to patients attacked by phlebitis, on account of the danger of embolism, or to those with varicose veins in whom a rupture might occur. It is also recommended that a patient should not be treated immediately after a meal, for fear of nausea and vomiting.

With regard to the results of electropyrexia in ocular conditions, A. Halphen and J. Auclair have reported that the atrophy of the optic nerve in persons with tabes is sometimes improved. Clear widening of the visual field has been remarked. Suzanne Schiff-Wertheimer reported the histories of two patients suffering from tabes with white papillae, who were subjected to short wave therapy and in whom the ocular condition remained unchanged. Injection of a bismuth preparation was made at the same time. The treatment was of five months' duration in one case and of six months' duration in the other. This author did not draw any conclusion from these trials, but insisted on the apparent innocuity of the treatment.

COMMENT

On the basis of my study of cases I can say that pyretotherapy makes for interesting successes in the field of ophthalmology. Among the diverse ocular complaints which derive benefit from artificial fever, one must place syphilitic lesions first. With pyretogenic treatment one can stabilize tabetic atrophy of the optic nerve in cases in which no treatment had previously succeeded in checking such lesion, the evolution of which is regularly progressive, as Morax said in the last edition of his history. Pyretotherapy does not, it is evident, give a perfect result, as it does not recover what is destroyed. But in the case of tabes one must be content with little and consider as a real success the stabilization of a lesion. And what about the modifications that one obtains in regard to the pupils? I shall simply recall that Dor said, in

his report on the treatment of ocular syphilis, that it is very difficult, in general, to cure pupillary troubles.

The efficaciousness of pyretotherapy being established in ophthalmology, one naturally asks oneself which pyretogenic agent should be given the preference and what the indications are.

In reality, all the methods are good, since happy results can be claimed for each. However, the greatest number of patients with atrophy of the optic nerve whom I have read of as having been favorably influenced had been subjected to malariotherapy. It is true that this is the oldest pyretogenic process. But let it not be forgotten that the authors have speculated as to whether the fever is the only factor in malarialization and whether there are not complex actions which accompany it.

The malaria cure has its inconveniences. First, there is the gravity of an inoculation with all its train of complications. Furthermore, it is a blind process which demands that the patient spend several weeks in an institution, which is certainly a disadvantage from an economic point of view.

For all these reasons, with equal chances of success, one must prefer a method less dangerous, more sure and easier to carry out.

Dmelcos therapy seems especially successful against acute and subacute infectious conditions, for which shock treatment has proved itself valuable for numerous years. But why does one want to substitute a pyretogenic agent for shock, which has never caused any grave troubles in the realm of ophthalmology and to which one owes so much success? Moreover, dmelcos therapy demands a great deal of prudence and often provokes great discomfort.

The same may be said of pyrifer, the use of which is less widespread.

And what is to be thought of sulfur in oil for which very interesting results can be claimed? It is still a product the use of which requires investigation. Notwithstanding, it would seem that injections at a really active concentration are very painful. Magitot stated that he has abandoned the use of sulfur in oil on account of the pain.

One arrives at a consideration of Kettering's hot air chamber and the short waves. They are the physical agents that realize pure hyperthermy and that have the great advantage of being able to start the fever and to proportion it at will. Certainly, they are agents which are still in their trial period. But if the results of Culler and Simpson are confirmed in the future, it is not impossible that the air-conditioned chamber will become the instrument chosen for treating ocular complaints by artificial fever, although it requires a great deal of good will on the part of the patient.

Concerning the indications for pyretotherapy in the field of ophthalmology, at the head of the list may be cited simple syphilitic atrophy of the optic nerve and pupillary troubles of syphilitic origin, for which no other treatment exists. One must also think of pyretogenic agents in cases of arachnoiditis of the optic chiasm of syphilitic origin; in cases of keratitis, in particular in those of parenchymatous keratitis of syphilitic origin, and in cases of inflammation of the uveal tract of no matter what origin.

CONCLUSIONS

I have reviewed a certain number of ocular maladies treated by hyperprexia. From these statements I shall draw a few practical conclusions.

I insist, first of all, on the utility of therapeutics by artificial fever in simple syphilitic atrophy of the optic nerve. Certainly, the results are neither constant nor perfect, but this is the only treatment which can check the lesion and so prevent the patient from becoming blind.

The pyretogenic processes also cause syphilitic pupillary troubles to disappear. Syphilitic parenchymatous keratitis, as well as keratitis, iritis, and iridocyclitis of all kinds, can be greatly benefited.

In cases of atrophy of the optic nerve it would seem that therapy with sulfur in oil and malarialization are the most efficacious forms of treatment. If one has recourse to malaria therapy, it is recommended that it be attenuated, the temperature not exceeding 40 C., and that quinine be given at the beginning of the inoculation.

Sulfur in oil seems to be indicated for pupillary troubles, and dmelcos for acute and subacute inflammatory conditions. In these cases of inflammation it would be sometimes useful to combine therapy shock with dmelcos.

As for treatment with the Kettering hypertherm and with the short waves, this is still in the experimental stage. One must, however, recognize that the results obtained with the Kettering hypertherm are particularly interesting, the more so as treatment with this apparatus is a physical method of pyretotherapy, in which everything therefore depends on the contribution of external calories, the amount of which one can easily regulate.

It is recommended that in cases of syphilitic complaints chemotherapy be combined with hyperpyrexia. Chemotherapy should be prolonged for quite a while.

One must also insist on the necessity of starting pyretotherapy as soon as possible, at the beginning of the complaint.

THE PROBLEM OF GLAUCOMA

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To the student of ophthalmologic history glaucoma presents a double problem. Did glaucoma prevail in ancient times, and, if it did, was it recognized as such by ancient physicians? There is no positive evidence in ophthalmologic literature to show that glaucoma was known earlier than a century ago. The clinical history, however, favors the belief that glaucoma is a disease of great antiquity. All known predisposing factors of glaucoma, such as old age, climatic conditions, hereditary and racial influences, nervous strain, inflammatory diseases of the eye, errors of refraction and other such possible causes, have always prevailed.

The identification of glaucoma in the early stages of the disease, however, appears to be of comparatively recent date. Ancients recognized it only in the final stage of the disorder as a special form of amaurosis which contributed to the widespread blindness prevailing in the ancient East.

GLAUCOMA AMONG THE ANCIENT HEBREWS

Both the Old Testament [1] and the New Testament [2] abound in cases of amaurosis, many of which were undoubtedly caused by hypertension of the eyeball. Four cases of blindness in the Old Testament are particularly suggestive of glaucoma, and I cite them here in chronological order:

1. "And it came to pass when Isaac was old that his eyes were dim so that he could not see." [3]

2. "Now the eyes of Israel were dim for age so that he could not see." [4]

3. "Now Eli was ninety and eight years old and his eyes were set; so that he could not see." [5]

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1. Genesis 27:1 and 40:10. Exodus 4:11. Leviticus 19:14 and 21:18. Deuteronomy 15:21, 27:18 and 28:29. I Samuel 4:15. II Samuel 5:6. I Kings 14:4. Isaiah 29:18 and 35:5. Zephaniah 1:17. Psalms 146:8. Job 29:15. Baruch 6:37.

2. Matthew 9:27-28, 11:5, 12:22, 15:30-31, 20:30 and 21:14. Mark 8:22 and 10:46. St. Luke 7:21-22, 14:13, 21 and 18:35. St. John 5:3, 9:1, 10:21 and 11:37. The Acts 13:11.

3. Genesis 27:1.

4. Genesis 48:10.

5. I Samuel 4:15.

4. "Now he [Ahijah] could not see; for his eyes were set by reason of old age." [6]

Before entering into a discussion of the clinical history in these cases, it should be pointed out that the word "dim" in cases 1 and 2 (meaning indistinct), as rendered in the revised version, is misleading. The Hebrew text has a different word for each case. In case 1, the term *wattikhena* is used, which should be rendered "extinguished," [7] for according to the Biblical narrative Isaac suffered from total loss of sight. The patriarch could distinguish his two sons only by the sound of their voices and by his sense of touch. In case 2 the Hebrew text has the word *kabdu*, which does not mean dim. It is derived from the root *kabad*, meaning heavy [8] or hard,[9] and accordingly the text of case 2 should read "Now the eyes of Israel were heavy (or hard) from age so that he could not see." In each case the writer of Genesis gives as the cause of blindness old age, and in the case of Israel the writer emphasizes that the blindness of the patriarch was due to heaviness (or hardness) of the eyes, which he ascribed to old age.

More significant are cases 3 and 4. The Hebrew word *kamu* literally means "they stood still." The English version "eyes were set" practically expresses the same idea. In other words, the blind eyes of Eli and Ahijah were at a standstill. They could not fix on objects in front of them, as is characteristic in amaurosis following glaucoma, in which perception of light is gone; there is a peculiar stare and the eyes either do not move or do so aimlessly. This peculiar stare could not be mistaken for senile cataract, for in this condition there is usually some perception of light; the ocular muscles keep working in all directions to find a fixation point in order to locate luminous objects in front of the eye or to recognize dark objects in daylight.

The etiologic factors in all the cases cited bear a striking similarity; old age is given as the main cause of blindness. It is now generally agreed that the cause of glaucoma lies in those degenerative processes which are inseparable from the wear and tear of the living organism

6. I Kings 14:4.

7. (*a*) In Hebrew the term *Or* applies to sight, light and fire, as seen from Psalms 38:11: "The light (*or*) of my eyes is gone." The word *Kabah* (extinguished) applies also to blindness (Talmud Pesahim 62, folio b). "Kabah meor emayim" (extinguished is the light of the eyes) (Hag. 5: folio b). H. Gunkel in his commentary on Genesis (Genesis, ed. 2, Göttingen, 1902, p. 277; cited by Kotelmann, L. W.: [*b*] Die Ophthalmologie bei den alten Hebräern, Hamburg, L. Voss, 1910, p. 235, footnote 1569) renders the German version as follows: "Es begab sich, als Isaaq alt geworden und sein Augenlicht ganz erloschen war" (and it came to pass when Isaac was old and his eyes were extinguished).

8. Exodus 17:12. II Samuel 14:26. Psalms 38:4.

9. Exodus 8:11, 28:9 and 7:34.

occurring in old age.[10] In all the aforementioned cases there is a history of mental and physical strain, which was recognized by ancient Hebrews as a predisposing factor of ocular trouble.[11] All these Biblical characters were living in the same environment and climate. Two pursued the life of shepherds, exposed to the hot sun during the day and to the cold and damp Palestinian air at night. The contrast between the glare of the sun by day and the cold damp night air is considered a factor in causing glaucoma.[12] (Maynard observed that more patients with glaucoma were under treatment during the rainy season in Calcutta hospitals than at any other time. He attributed this to the diminution of light which marks the cold and rainy season of India.)

All four of the affected persons just mentioned were members of the Semitic race, among whom glaucoma is especially prevalent.[13] In cases 1 and 2 the characters showed a hereditary predisposition to glaucoma[14]; in cases 1, 3 and 4 the characters suffered total loss of vision; in case 2 sight was only partly impaired, and in all the cases the loss of vision was bilateral. If unilateral blindness, as well as amaurosis not contingent on old age, is barred, and senile cataract is eliminated for the aforementioned reasons, the clinical history in the four cases cited is strongly suggestive of glaucoma.

GLAUCOMA AMONG THE GREEKS

While the prevalence of glaucoma among ancient Hebrews is based more or less on conjecture, early Greek physicians appear to have iden-

10. Risley, S. D.: An Injury Regarding Increased Tension of the Eyeball, Ophthalmoscope **12**:80, 1914.

11. The Psalmist complained, "Mine eye is consumed because of grief. It waxed thus because of all mine enemies" (Psalms 6:8). "Have mercy on me, O, Lord, for I am in trouble. Mine eye is consumed with grief; my strength faileth me; the light of mine eye is also gone from me" (Psalms 38:11). Seidel has observed two cases in which intense psychic excitement was followed at once by a glaucomatous reaction, in one instance for one day, and in the other for a week. He is of the opinion that emotion affects the vasomotor fibers, causing fluids in the uveal tract (Psychic Factor in Intra-Ocular Fluid Exchange, Arch. Ophth. **9**:494 [March] 1933).

12. "Thus I was in the day, the drought consumed me and the frost by night" (Genesis 31:40). The continuous exclusion of light from the eye is known to produce mydriasis, thus predisposing to glaucoma.

13. Familial influence on the incidence of glaucoma is well recognized; the mode of action is ascribed to anatomic peculiarities and common environments. Laqueur stated that of the three ophthalmologists of his generation who suffered from glaucoma, Laval and he were Jews (Jackson, E.: Ophthalmic Year-Book, Chicago, Ophthalmic Publishing Company, 1910).

14. A. Brückner in a recent article has shown that glaucoma is hereditary in nature and that it attacks successive generations in the same decade of life. He believes it to be due to the influence of the vegetative nervous system and to climatic conditions (Newer Knowledge of the Diagnosis and Therapy of Primary Glaucoma, Schweiz. med. Wchnschr. **66**:1264 [Dec. 12] 1936).

tified the disease in its late stage by a greenish discoloration of the pupil (green star).[15] Hippocrates in his "Aphorisms" [16] pointed out that among the well known diseases of the eye there is a disorder known as glaucosis, which is marked by a sea-colored pupil. "If the pupil [which he considered to be the center of sight] becomes sea-colored, sight is destroyed and amaurosis of the other eye often follows." [17]

Hippocratic writers stressed the color of the pupil as of great diagnostic value. Several colors of the pupil were recorded—light yellow, silver-gray, green or light blue, and deep blue. These colors were taken by the Greeks to identify various pathologic changes in the eye. The light yellow and silver-gray pupil referred to senile cataract (gray star).[18a] The green or blue color was referred to by the Greeks as glaucosis.

Plato described the color of the pupil in glaucosis as "a cornflower blue mixed with white exhibiting a water blue color." [18b]

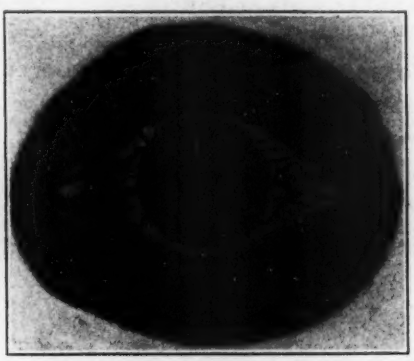

Fig. 1.—Photograph showing absolute glaucoma.

The gray star was recognized by Aristotle, who attributed the change of color in the pupil to the abstraction of fluid from the ocular organ. "In advanced age," he stated, "all parts of the body have a tendency to dryness." [18c]

15. According to Julius Hierschberg, the term glaucosis signifies blue.

16. Hippocrates; Maximilien, P. E.: Lettre edition, Paris, 1839-1861, sect. 3, p. 31; sect. 4, p. 502.

17. Sea-blue refers to the color of the Mediterranean Sea. Being illuminated almost continually by a bright sunshine, it reflects the blue sky and appears light blue. Franz Delitzsch is of the opinion that among the Semites dimness of light was known as "blue." The "gray star" or "black star" was known as "blue star" (Der Talmud und die Farben. Nord und Süd, Leipzig, 1878, p. 261; cited by Kotelmann, L. W.: Die Ophthalmologie bei den alten Hebräern, Hamburg, L. Voss, 1910, p. 240, footnote 1602).

18. Cited by Kotelmann, L. W.: Die Ophthalmologie bei den alten Hebräern, Hamburg, L. Voss, 1910, (*a*) p. 239, footnote 1595; (*b*) p. 239, footnote 1600; (*c*) p. 237, footnote 1587.

Under the term amaurosis ancient writers lumped together all cases of blindness without reference to their etiologic factors. They considered blindness a disease and differentiated between the various forms of amaurosis by the color of the pupil. According to a manuscript ascribed to Galen, glaucomatous amaurosis is caused by pathologic changes in the humors of the eye which change the fluids to a blue color. The author probably was referring to postiritic glaucoma.

GLAUCOMA AMONG THE ROMANS

According to Ephesus Rufus (about 50 A.D.), a contemporary of Celsus, early Roman ophthalmologists considered glaucosis and hypochyma (cataract) identical terms. "Later writers," he stated, "distinguished between these two diseases. The first they applied to a watery crystalline lens that changed its color to blue; the second to a turbid fluid which settled between the iris and the lens (cataract). Both diseases terminated in amaurosis."

CONCEPTION OF GLAUCOMA AMONG BYZANTINE PHYSICIANS

In the centuries following the decay of the Roman Empire, throughout the Byzantine period down to the sixth century, no new thought in the field of ophthalmology was advanced. Medical writers depended entirely on the traditional works of Hippocrates, Galen and Celsus. Their authority was accepted without any question. Any change in the orthodox tradition was based not on evidence but on conclusions reached by comments and speculations on old texts. During these centuries, glaucoma was considered a form of cataract and was known as cataracta complicata cum amaurosi; the loss of vision was ascribed to desiccation of the lens brought about by conditions such as mydriasis, miosis, synchysis, and opacities in the aqueous.

There were, however, among the Byzantine ophthalmologists those who recognized the difference between amaurosis following hypochyma and that succeeding glaucosis. In the first instance the patient retained perception of light, while in the second this power was completely lacking. From a therapeutic point of view, they considered blindness following hypochyma amenable to treatment but that produced by glaucosis hopelessly incurable.

Alexander of Tralles (525 A.D.) in the section on ocular diseases in his medical work described the type of patients in whom glaucosis may be present: "Loss of vision and glaucosis is an affection of old people. Blue-eyed individuals are more prone to be affected than those who have dark eyes. Dilated pupils are more apt to be found in those who have large dark eyes."

One century later, Paulus Aeginta (625-690) followed the dictum of the Greeks and differentiated between amaurosis arising from glaucoma and that caused by other conditions. He asserted that the loss of vision in the former type is marked by blue discoloration of the pupil, but in the latter case the color of the pupil is not changed.

From the literature cited it is evident that the term glaucoma as understood by the ancients had no pathologic significance. The supposed bluish or greenish discoloration of the pupil is not typical even of the later stages of glaucoma, for such a green reflex of the pupil may be found among the aged, even in healthy eyes, as in cases in which the media are not completely transparent and particularly when the pupil is dilated by atropine.

MIGRAINE OF THE EYE AND HARDNESS OF THE EYEBALL

It was not until the middle of the fourteenth century that a certain form of ophthalmia was identified which approximated the modern description of glaucoma. Under the name "migrain of the eye" Sams-al-din (1348), an Arab ophthalmologist, described an ocular disorder characterized in its acute stage by hemicrania, deep-seated inflammation of the eye and turbidity of the humors, followed occasionally by cataract and permanent dilatation of the pupil. He stated that if the disease became chronic it was associated with tenseness of the eyeball and impairment of vision. Though far in advance of the times, this account of absolute glaucoma failed to attract any attention, and for three centuries thereafter this disease was not identified directly or indirectly by ophthalmologic writers.[19]

RICHARD BANISTER'S DIAGNOSIS OF GUTTA SERENA

Three centuries later, Richard Banister (1626) in his "Breviary of the Eye" gave a description of a form of incurable cataract, gutta serena, which was analogous in its symptoms to absolute glaucoma. He pointed out the difference between gutta serena (incurable cataract), in which the blindness is associated with a transparent pupil, and gutta obscura (curable cataract), in which the blindness is associated with an opaque pupil. He suggested four different diagnostic signs by which the incurable cataract might be recognized: (1) hardness of the eyeball, (2) no perception of light, (3) long duration and (4) no dilatation of the pupil (if the sound eye was bandaged). He concluded that if these symptoms were present the cataract was hopelessly incurable.[20]

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19. Sorsby, Arnold: A Short History of Ophthalmology, London, John Bale, Sons & Danielsson, Ltd., 1933, p. 50.

20. Banister, Richard, cited by Sorsby, A.: Hardness of the Eye: An Historical Note, Brit. J. Ophth. **16**:292 (May) 1932.

The observations of Banister, like those of his Arab predecessor, appear to have fallen on stony soil. The cardinal symptom of absolute glaucoma was lost sight of again for a period of one hundred and twenty-five years. It was rediscovered by the German anatomist Johann Zacharias Platner [21] (1694-1747), of Leipzig, who, according to Terson, was the original discoverer. This view, however, because of the aforementioned evidence is hardly tenable. While Platner may not have been aware of Banister's discovery, he certainly cannot claim priority.

CONFUSION OF GLAUCOMA WITH CATARACT

Both Banister and Platner had no knowledge of the immediate cause of the hardness of the eyeball. They thought that it was a complicated form of cataract and that certain pathologic changes of the crystalline lens might in some way be responsible for the tenseness of the globe.

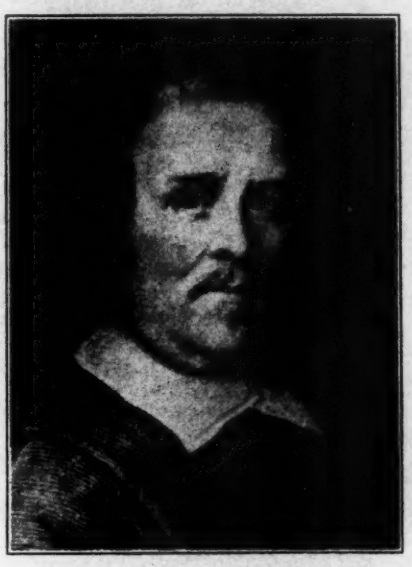

Fig. 2.—Portrait of Hermann Boerhaave.

This opinion was likewise held by many contemporaries, among whom might be mentioned the celebrated Herman Boerhaave (1668-1738), who under the name of De Cataracta described glaucoma as a malignant form of cataract that begins with acute pain and terminates in amaurosis.[22]

21. Platner, J. Z.: De motu ligamenti ciliaris in oculo, Leipzig, ex. off. Langenhemiana, 1738; Institutiones chirurgiæ rataionalis tum medicæ tum manualis in usum discentium, Leipzig, The Author, 1745; cited by Sorsby, A.: Brit. J. Ophth. **16**:292 (May) 1932. This author contended that the ciliary body performs motor and secretory functions (cited by Snellen, H.: A Historical Essay on the Development of Our Present Knowledge of Glaucoma, Ophth. Rev. **10**:33, 1891).

22. Boerhaave, Hermann: Prælectiones publicæ de morbus oculorum, Paris, G. Cavalier, 1748, p. 107.

Beer [23] (1763-1821), of Vienna, thought that absolute glaucoma terminating in cataract and blindness was due to a form of malignant iritis distinguished from the benign type by greenish discoloration and dilatation of the pupil. He thought that, as in other forms of iritis, the underlying cause was a gouty and arthritic diathesis (hence the name "ophthalmia arthritica").

William Lawrence [24] (1783-1867), the English ophthalmologist, was of the same opinion. He thought that glaucoma was a chronic form of inflammatory iritis which affects the posterior coats of the eye. Among the symptoms he also stressed the greenish discoloration of the pupil. It is strange that neither Beer nor Lawrence mentioned hypertension as a cause.

Demours [25] (1762-1836) was the first to describe the symptom of "colors of the rainbow" (halo vision) around a light. This and increased tension of the eyeball he considered the essential symptoms of glaucoma. The associated pain he ascribed to oversensitiveness of the nervous system, and he attributed the disease to gout and rheumatism.

The etiology of this mysterious disease has always been the object of speculation. Galen thought it due to a pathologic alteration in the humors of the eye, which change from transparent crystal to dark blue, impairing the view of the visual spirit. Since then it has been variously regarded as a disease of the crystalline lens, a disease of the iris, an effusion between the retina and choroid, a manifestation of gout and rheumatism, an inflammation of the vitreous and a form of cataract.

BRISSEAU AND HIS DISCOVERY

The great interest manifested in the study of the eye by Rolfinck (1529-1673) and, a few years later, by Maître Jan (1650-1730), and particularly the anatomic and pathologic studies on enucleated eyes by Brisseau,[26] cleared the confusion between cataract and glaucoma (1709). Brisseau [27] is said to have dissected the eyes of Bourdelat, the physician of Louis XIV, who was blind from glaucoma and who willed his eyes for experimental research. His preconception led him to search first in Bourdelat's eyes for opacities in the crystalline lens. When, to his amazement, he found the crystalline lens transparent and in normal condition, he came to the conclusion that glaucoma is in no way related

23. Beer, Joseph: Lehre von den Augenkrankheiten, Vienna, C. F. Wappler, 1792. Beer was often called the "Father of Ophthalmology."

24. Lawrence, William, cited by Sorsby,[19] p. 21.

25. Demours, Anthony P., cited by Wood, C. A.: (*a*) American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 5405.

26. Brisseau, Michael, cited by Gordon, B.: The Problem of the Crystalline Lens, Arch. Ophth. **14**:774 (Nov.) 1935.

27. Brisseau, Michael, cited by Cirincione, G.: Appunti per il tratto di ottalmologia: Glaucoma, Ann. di ottal. e clin. ocul. **58**:3 (Jan.); 99 (Feb.) 1930.

to cataract. But he committed a different error. While searching for the cause, Brisseau observed opacities in the vitreous of Bourdelat's eyes, and he took this unusual phenomenon to be the cause of his friend's blindness. Thus he took out, as it were, the disease from the lens and moved it back into the vitreous.

SCARPA AND HIS DESCRIPTION OF AMAUROSIS

During the latter half of the seventeenth century and the beginning of the eighteenth century, glaucoma was looked on as a form of amaurosis distinguished from other cases of blindness by definite signs.

Fig. 3.—Portrait of Antonio Scarpa.

Antonio Scarpa [28] (1752-1832), the famous Italian anatomist and ophthalmologist, in his "Treatise of Diseases of the Eye," under the caption "Amaurosis" described (1801) a form of amaurosis which is typical in its symptoms of the later stages of primary glaucoma. Among other things, he stated that the pupil "is so much dilated as to appear as if the iris were wanting, having also an unequal or fringelike margin; in which the bottom of the eye, independently of the opacity of the crystalline lens, has an unusual paleness, similar to horn, sometimes inclining

28. Scarpa, A.: A Treatise on the Principal Diseases of the Eye, translated from the Italian, with notes by James Briggs, London, T. Cadell and W. Davies, 1818, p. 455.

to green, reflected from the retina, as if from a mirror; which are accompanied with pain of the whole head, and with a constant or an intermitting sense of painful tension in the eyeball." In this description Scarpa pointed out the most essential symptoms of primary glaucoma which could be recognized without the aid of the ophthalmoscope, i. e., tension of the eyeball, headache, dilated pupils, cloudiness of the cornea and green discoloration of the pupil. It is surprising that in the literature on glaucoma no credit for pointing out the important symptoms was given to Scarpa.

Thirty years later (1831) Fabini,[29] professor of diseases of the eye at the University of Pest, stated that he frequently observed in his clinic patients whose eyeballs were "as hard as stone." He attributed the hardness to changes in the elasticity of the tunics of the eyeball. The prognosis of such cases he thought to be very grave.

Fig. 4.—Portrait of William Mackenzie. (From Wood, Casey A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 10, p. 7568.)

RECOGNITION OF PRIMARY GLAUCOMA BY HARDNESS OF THE EYEBALL

To William Mackenzie[30] is frequently credited the discovery of hardness of the eyeball in glaucoma. This, in view of the literature cited, is not tenable. Even his priority for the surgical device of paracentesis

29. Fabini, J. T.: Doctrina de morbus oculorum, Pesthini, O. Wigand, 1830, p. 23.

30. William Mackenzie considered glaucoma to be a form of cataract, the difference between senile cataract and glaucomatous cataract being that "In glaucomatous cataract the eyeball always feels firmer than normal while in senile cataract there is always the usual degree of resistance to finger pressure" (Practical Treatise on the Diseases of the Eye, London, Longman [and others], 1830). In the fourth edition of his work (1854) he stated that he ascribed the symptom to a troublesome choroid. In this edition he advocated paracentesis of the cornea as a prophylaxis and cure for glaucoma. The beneficial result, however, turned out to be of temporary success.

of the cornea for the relief of increased intra-ocular tension might be questioned, for Desmarres[31] (1810-1882), of Paris, had resorted to the same operation for the same purpose some years before Mackenzie (1848).

In the United States, as late as 1837, glaucoma was still looked on by some writers as a form of amaurosis. Increased intra-ocular tension was not considered as the main symptom of the disease. Littell,[32] a surgeon of the Wills Hospital of Philadelphia, gave the following definition: "Glaucoma is an affection resembling amaurosis in many of its symptoms, and principally characterized by a green, or yellowish discoloration of the vitreous humor, and impairment, or total loss of vision." He added, "It is attended with pain, slight in the commencement but progressively increasing, and a sense of fullness or tension in the globe, which is preternaturally hard to the touch." He adhered to the old notion that the discoloration of the pupil is the main diagnostic feature of glaucoma.

SCIENTIFIC APPROACH TO THE STUDY OF GLAUCOMA

While the discovery of hypertension of the globe facilitated the recognition of simple glaucoma early in the disease, in some cases the recognition of this condition by digital pressure could not be relied on unless the tension was high. It requires trained fingers and a delicate sense of touch to detect a high, a normal or even a medium amount of hardness. Moreover, increased intra-ocular tension, even when detected with a delicate tonometer, does not always signify glaucoma, nor does the absence of hypertension exclude glaucoma.[33] The diagnosis based on intra-ocular tension is rather of indirect value; the most important thing is to recognize the damage caused to the eye by the intra-ocular pressure. This was realized by the invention of Helmholtz (1821-1893).[34] His ophthalmoscope made possible the detection of glaucoma by observing an excavation in the disk and has enabled the surgeon to watch the pathologic changes in the papilla caused by the pressure within the eye.

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31. Desmarres, L. A.: Traité théorique et pratique des maladies des yeux, ed. 2, Paris, Germer-Baillière, 1858, vol. 3, p. 737. Desmarres' secondary knife is still used by some European surgeons to split the cornea.

32. Littell, S., Jr.: A Manual of the Diseases of the Eye, ed. 1, Philadelphia, J. S. Littell, 1837, p. 183.

33. Arnold Knapp contended that the absence of hypertension does exclude glaucoma (Association of Sclerosis of Cerebral Basal Vessels with Optic Atrophy and Cupping, Arch. Ophth. **8**:637 [Nov.] 1932).

34. Helmholtz, H.: Beschreibung eines Augen-Spiegels zur Untersuchung der Netzhaut in lebenden Auge, Berlin, A. Förstner, 1851.

Julius Jacobson, of Königsberg,[35] is credited with having first studied the interior of the eye with the ophthalmoscope in cases in which glaucoma was suspected. His paper on the subject (1853) is of historic interest, although his conclusions are rather of a negative character.

A year later (1854) Jaeger [36] (1784-1871), of Vienna, observed with the ophthalmoscope changes in the appearance of the papilla, which he erroneously described as "globular swelling."

VON GRAEFE AND HIS SCHOOL

Jaeger's illustrious student, von Graefe [37] (1828-1870), at first committed the same error. Both master and student seem to have been led to this error by the preconceived theory that the change in the disk is caused by exudates and dilated vessels in the optic papilla.

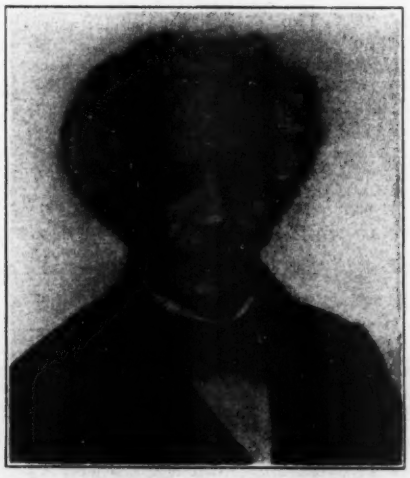

Fig. 5.—Portrait of Fred Jaeger. (From Wood, Casey A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 9, p. 6702.)

It should be remembered that prior to the invention of the ophthalmoscope only the secondary type of glaucoma was identified. The opinion prevailed that hardening of the eyeball is due to a congestive disturbance

35. Jacobson, Julius, cited by Garrison, F. H.: An Introduction to the History of Medicine, Philadelphia, W. B. Saunders Company, 1913, p. 552.

36. Jaeger, E.: Ueber Staar und Staaroperationen, Vienna, L. W. Seidel, 1854.

37. von Graefe, A.: (*a*) Vorläufige Notiz über das Wesen des Glaucoma, Arch. f. Ophth. **1**:371, 1854-1855; **2**:202, 1855-1856; (*b*) Ueber die Iridectomie bei Glaucom und über den glaucomatösen Prozess, ibid. **3**:456, 1857; (*c*) Weitere klinische Bemerkungen über Glaucom, glaucomatöse Krankheiten und über die Heilwirkung der Iridectomie, ibid. **4**:127, 1858; (*d*) Weitere Zusätze über Glaucom und die Heilwirkung der Iridectomie, ibid. **8**:242, 1862.

of the iris or the choroid. Both these conditions were thought to affect the clearness of the lens and vitreous, which resulted in blindness. The ophthalmoscope revealed that the eye may be glaucomatous without any pathologic changes in the uvea or in the outward appearance of the eye.

Weber,[38] a German physician, in 1856 was the first to demonstrate the cupping of the disk now recognized as the most important symptom of primary glaucoma. He also demonstrated by the direct method the different depths of the papilla in the various stages of glaucoma by the parallactic movements which occur when the examiner changes the ophthalmoscope in different directions.

After this discovery, Heinrich Müller,[39] already famous for his investigation in the field of pathologic anatomy of the eye, observed excava-

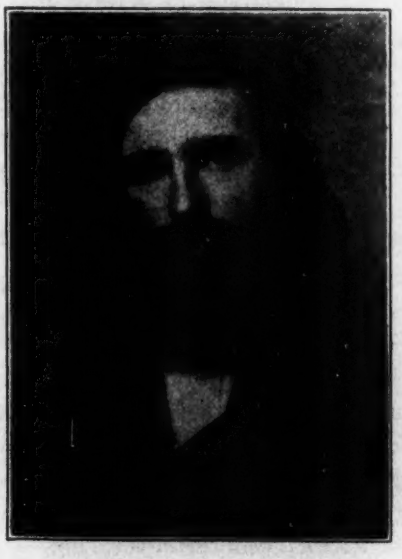

Fig. 6.—Portrait of Albrecht von Graefe.

tion of the papilla in enucleated eyes from glaucomatous patients. He ascribed the depression in the papilla to increased intra-ocular pressure.

With this knowledge, Donders[40] (1818-1889) proclaimed that glaucoma simplex is the basic form of glaucoma. He stated that the inflammatory symptoms which accompany it are only secondary.

38. Weber, A.: (*a*) Ein Fall von partieller Hyperämie der Chorioidea bei einem Kaninchen, Arch. f. Ophth. (pt. 1) **2**:133, 1856; (*b*) Die Ursache des Glaucoms, ibid. **23**:1, 1877.

39. Müller, Heinrich: Beschreibung einiger von Prof. v. Graefe extirpirter Augäpfel, Arch. f. Ophth. (pt. 1) **4**:363, 1858.

40. Donders, Francis C.: (*a*) Die zigtbare verschijnselen van bloedsomloop in het oog, Arch. f. Ophth. (pt. 2) **1**:75, 1854-1855; (*b*) On the Anomalies of Accommodation and Refraction of the Eye, translated by W. Daniel Moore, London, New Sydenham Society, 1864, p. 208.

VON GRAEFE AND IRIDECTOMY

An early diagnosis of glaucoma thus having been made possible by digital palpation of the eyeball [41] and by ophthalmoscopic inspection of the fundus, the most perplexing problem which remained was how to check the progress of this dreadful disease. The first to offer a practical solution to this vexing problem was Albert von Graefe [37a] (1856). While studying with the ophthalmoscope the changes in the fundus preceding the final stage of glaucoma, von Graefe became convinced that the increased pressure was not a mere complication but was the cause of all the symptoms of the disease. To relieve the pressure he applied his energy, his resourcefulness, his keen power of clinical observation and his masterly skill as a surgeon. His efforts were soon crowned with success. The discovery of iridectomy to combat glaucoma turned out to be one of the most important events in the history of ophthalmology of the nineteenth century.

This discovery of iridectomy did not come to von Graefe by mere chance. For many years before he had resorted to a similar surgical technic for the relief of staphyloma of the cornea. In the latter condition he noticed that the escape of the aqueous through the wound resulted in marked regression of the protrusion, and he tried the same technical procedure to alleviate the tension in glaucoma.

EARLY HISTORY OF IRIDECTOMY

The technic of iridectomy was not entirely new. William Cheselden (1618-1752) performed a somewhat similar operation for making an artificial pupil in cases in which the transparency of the pupil was impaired from congenital or inflammatory causes or from the couching operation for cataract. His technic, which consisted of introducing a needle through the sclera, was, however, not well adapted for the intended purposes. It was of only temporary value, as the opening soon became closed by adhesions, and it frequently caused damage to the ciliary body. This operation was modified eleven years later by Samuel Sharp (1774-1778). His method was transfixing by one incision the cornea and the iris across the anterior chamber. Sharp's technic fared no better than that of Cheselden. It made no impression on his contemporaries. Sixty-one years later (1801) the operation was revived by Anthony P. Demours (1762-1836), who claimed it as his own. Other modifications of this operation followed, among which should be men-

41. William Bowman (On Glaucomatous Affectations, and Their Treatment by Iridectomy, Brit. M. J. **2**:377, 1862) ascertained by digital touch the different degrees of tension. Starting from normal, three degrees may be elicited in each direction—plus 1, 2 and 3 and minus 1, 2 and 3.

tioned the division of the sphincter muscle at the pupillary margin (iridotomy), but this also fell into disrepute. It was finally resurrected by Joseph Beer (1763-1821), who devised a knife (1798) for the operation. Beer performed iridectomy in cases of impaired vision due to leukoma, corneal adhesions or staphyloma, as a means of forming an artificial pupil.[42]

Shastid [43] has expressed the opinion that credit for priority in regard to the iridectomy operation as performed for the treatment of glaucoma belongs not to von Graefe but to Beer. Be this as it may, ophthalmologists are indebted to von Graefe for introducing this device for the prevention of blindness in simple glaucoma at a time (1857) when even temporary relief from miotics was not known (miotics were discovered in 1875).

In reading the ophthalmologic literature of that period one is greatly amazed by the bitter controversy evoked by the discovery of iridectomy. The participants did not always refrain from personal abuse. Some surgeons looked on the operation as a harmful experiment; others objected to iridectomy because the rationale for the operation was rather vague. It must be remembered that von Graefe first ascribed the lowering of the tension after the operation to the escape of the aqueous through the opening of the incision. But, observing that the anterior chamber refills within twenty-four hours after the operation, he advanced the theory that the ocular fluid is secreted partly or wholly by the iris, and that by cutting a part of the iris the secretion becomes permanently lessened. Neither of these theories was satisfying.

DE WECKER AND HIS IDEA OF CONTINUOUS FILTRATION

It was due to the persistent efforts of his disciple Louis de Wecker (1836-1906) that the unreasonable opposition to von Graefe's skilful surgical methods subsided, and the curative value of iridectomy was established.[44]

De Wecker differed, however, from his master in the rationale for the decrease of tension after the operation. He advanced the opinion that the success of iridectomy depends on the continuous filtration of the ocular fluid through the cicatrix.[45]

Convinced of the soundness of his theory, he concluded that the beneficial results of the operation could be made more permanent if a fistula could be provided whereby the retained fluid could drain freely

42. Beer, Joseph, cited by Sorsby,[19] p. 57.

43. Shastid, T. H., in Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 5623.

44. de Wecker, L.: (*a*) cited by von Graefe[37a]; (*b*) Valeur de l'iridectomie dans le glaucome, Bull. et mém. Soc. franç. d'opht. **18**:1, 1901.

45. de Wecker, L.: (*a*) Ocular Therapeutics, translated and edited by Litton Forbes, Smith Elder & Co., 1879, p. 259; (*b*) p. 249; (*c*) pp. 249-259.

from the interior of the eye into the subconjunctival sac.[45b] This conclusion led to his device of sclerotomy and proved to be the basis of most surgical methods now in use for the treatment of glaucoma. De Wecker defined glaucoma as a disturbance of the equilibrium between secretion and excretion with an increase of the contents and tension of the eye, the severity of the attack depending on the degree and rapidity with which the balance is offset. He offered no solution as to the nature of the disturbance that offsets the balance of the ocular fluid.[44b]

Von Graefe deserves admiration also for presenting a graphic description of primary glaucoma which has since been accepted as classic by authors of textbooks. The symptoms, as pointed out by von Graefe, in addition to increased tension and excavation of the papilla, are acute supra-orbital pain, dilatation of the pupil, shallowness of the anterior chamber, cloudiness of the media, loss of corneal sensibility, rapid impairment of vision and a contracted field, all of which he attributed to the increased intra-ocular tension, particularly in cases in which such tension rises rapidly.[37b] Von Graefe was also first to point out the danger of administering atropine in the treatment of glaucoma, a practice which was then common.[37c]

Holth [46] has shown that von Graefe was the first to observe transitory leveling of the glaucomatous cup after the successful performance of iridectomy. "In this way I saw deep cavities change within a week into flat basin-like depressions," he stated.

After this disclosure of von Graefe, Lange [47] observed diminution in the depth of the glaucomatous cup after the use of miotics.

DISCOVERY OF ARTERIAL PULSATION

The effect of the pressure on the ocular circulation was the next step in the study of the fundus in glaucoma. The first to investigate this subject was Donders (1855-1856), who observed that digital pressure on the eyeball produces a venous and arterial pulse resulting in momentary blurring of vision. This important discovery led to the detection (1859) of arterial pulsation in glaucoma by von Graefe. The study of vascular pulsation was continued by Coccius (1872), who demonstrated that the harder the eye, the more marked is the arterial pulse, and that the pulsation of the central artery is the true index in the study of the various stages of glaucoma.[48]

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46. Holth, S.: On My Technique in Limbal Sclerectomy for Glaucoma, Ophthalmoscope **9**:87, 1911; **12**:347, 1914.

47. Lange, O.: Zur Lehre vom Glaukom, Klin. Monatsbl. f. Augenh. **2**:540. 1912.

48. Coccius: Arch. f. Ophth. **11**:373, 1872.

RATIONALE OF IRIDECTOMY

While the discovery of iridectomy has in a measure solved the problem of combating intra-ocular hypertension, the rationale of the operation still remains an open question. Von Graefe, who first ascribed the lowering of the tension after the operation to the loss of the aqueous through the opening of the incision, believed that the quantity of fluid in the eye does not change materially during life and, once lost, does not return to pathologic proportions.[37d]

Leber and Coccius [49] also attributed the decrease of the tension after the operation to the loss of membrane of the iris, not because it lowers the amount of secretion but because it opens a free communication for the passage of fluid between the anterior and posterior chambers.

Bowman assumed that the exposing of the zonula by the operation facilitates the passage of fluid from the vitreous to the anterior chamber, whence it is absorbed by osmosis.[50]

De Wecker [45c] contended that the success of iridectomy is dependent on the continuous filtration of the ocular fluid through the cicatrix.

Ulrich,[51] who expressed the belief that a water-proof iris is the cause of hypertension, theorized that the perforation of the iris removes the impenetrable condition of the iris and permits free communication of fluid between the chambers.

Nuel explained the effectiveness of iridectomy by the hypothesis that the ocular fluid is secreted by the iris. Thus when a part of the iris is cut away, less fluid will enter the eye.

Henderson suggested that iridectomy opens new avenues for excretion of the intra-ocular fluid through the edges of the coloboma, which, in his opinion, are never cicatrized.

Czermak [52] theorized that the cutting of the pectinate ligament forms a direct communication between the anterior and posterior chambers.[38b]

Weber [38b] asserted that the operation detaches the adhesions of the iris from the angle of the anterior chamber and reestablishes the normal outflow. This theory, which gained universal acceptance for a time, has lost ground of late. The studies of Troncoso and others have shown that the reopening of the angle is not a necessary condition for the success of iridectomy. These authors proved that the contents of the eye drain perfectly after iridectomy, even when the peripheral synechia is

49. Coccius, E. A.: Ueber Glaucom, Entzündung und die Autopsie mit dem Augenspiegel, Leipzig, I. Müller, 1859.

50. Bowman, W.: A Discussion on the Value of Iridectomy in Glaucoma, Tr. Internat. Cong. Ophth., 1872, p. 194.

51. Ulrich, R.: Studien über die Pathogenese des Glaucoms, Arch. f. Ophth. **30**:235, 1884.

52. Czermak, Wilhelm: Die augenärztlichen Operationen, Vienna, C. Geralds & Sohn, 1898, p. 181.

not detached. Troncoso attributed the beneficial results of iridectomy to drainage of the fluid through the edges of the coloboma, to the provision of intercommunication between the chambers and, in some cases, to the opening of the outlet that was blocked by the synechia.[53]

There are many other theories that offer an explanation for the curative effect of iridectomy in glaucoma, but so far no satisfactory elucidation has been given. The difficulty lies in the fact that, notwithstanding the extensive laboratory and clinical investigations, the pathogenesis of primary glaucoma is still terra incognita, and without a knowledge of the etiology, the treatment must necessarily remain symptomatic and empirical.

Fig. 7.—Portrait of Sir William Bowman.

SOURCE OF THE INTRA-OCULAR FLUID IN THE NORMAL EYE

When the problem of the intra-ocular tension in primary glaucoma was first approached, two theories were presented as to the source of the intra-ocular fluid in the normal eye. One was the stagnation theory, which maintained that the aqueous is formed at birth and unless influenced by disease remains unchanged throughout life. The other, known as the circulation theory, is that of Leber and his collaborators, which proposed that the aqueous keeps changing in the eye continuously.

The first theory, which received the support of early writers, has lost its prestige in recent years. The second theory, which is generally

53. Troncoso, M. U.: Closure of the Angle of the Anterior Chamber in Glaucoma, Arch. Ophth. **14**:557 (Oct.) 1935.

accepted, has received various explanations as to the mode of action. Leber thought that the aqueous is formed from the blood after having been filtered through the walls of the capillaries by the pressure of the blood. Seidel postulated that the aqueous is secreted by the glandlike epithelium of the ciliary body.[54] Friedenwald and Pierce contended that the aqueous is formed mainly by the ciliary processes by the mechanism of ultrafixation. The outflow through Schlemm's canal takes place under the influence of osmotic forces due to the pressure of the blood plasma in Schlemm's canal. The outflow mechanism of Schlemm's canal can take care of ten times the normal circulation, with a rise in the intra-ocular pressure of only a few millimeters of mercury.[55] Other investigators have stated the opinion that the secretion is formed by the blood but that before it reaches the anterior chamber it is filtered through the ciliary processes.

The theory which has gained ground recently is that of dialysis. It presumes the existence, in the walls of the capillaries, of a semi-permeable membrane which permits water and dissolved solids to pass through but blocks the passage of undissolved colloidal substances, rich fluids and proteins.

It is manifest from the brief review just given that the source, as well as the character, of the contents of the intra-ocular fluid in the normal eye is still a matter of speculation.

THEORIES OF INTRA-OCULAR HYPERTENSION

To the earlier pathologists who believed that all forms of glaucoma were secondary to ocular disorders such as diseases of the choroid, lens, iris and blood vessels, the etiology of glaucoma did not present any problem. It was ascribed to the antecedent disease, but since the ophthalmoscope revealed a primary form of the disease a knowledge of the cause is pertinent.

The theories advanced within the last seventy-five years to explain the cause of ocular hypertension would make up a volume by itself and would be entirely beyond the scope of this paper. A brief review of the leading theories, however, merits consideration.

Theoretically, the tenseness of the eyeball in primary glaucoma could arise from one of the following four causes: (1) hypersecretion, (2) retention of fluid within the globe, (3) anatomic changes within the eye and (4) changes in the composition of the intra-ocular fluids.

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54. Seidel, E., cited by Adler, F. H.: Is the Aqueous Humor a Dialysate? Arch. Ophth. **10**:11 (July) 1933.

55. Friedenwald, J. S., and Pierce, H. F.: Circulation of the Aqueous, Arch. Ophth. **8**:9 (July) 1932; **10**:449 (Oct.) 1933.

Von Graefe first assumed that the increased volume of the eyeball is due to hypersecretion of fluid from the iris and choroidal vessels as a result of the inflammation of that structure. The invention of the ophthalmoscope prompted him to change his view. That instrument, which made possible the recognition of primary glaucoma, did not show any pathologic changes in the choroid or the iris. He consequently postulated the theory of serous choroiditis, the existence of a disorder of the choroid in which the eye did not show any pathologic changes.[56] This view gained the support of many contemporaries, among whom might be mentioned his disciple, de Wecker.[45b]

Donders, who was first to maintain that glaucoma simplex is the typical form of the disease, also stated the belief that the oversecretion of the choroid is the basis of hypertension. The secretion, however, he thought is affected by nervous irritation of the choroid similar to that present in glands when certain nerves are stimulated. Hence he termed the process "neurosis secretion." [57]

Bowman [58] assumed that the hardness of the eyeball is due to the anatomic disproportion between the size of the eye and that of the crystalline lens, i. e., the existence of a congenital small eye with a normal lens or that of a normal eye with a large lens. "The decisive fact in determining the onset of glaucoma is the size of the eye in relation to the lens."

Priestly Smith [59] held that smallness of the cornea predisposes to glaucoma by the diminution of the perilenticular space through the resulting change of position of the ciliary body. He found that the cornea is, as a rule, smaller in glaucomatous eyes (measuring, on an average, 11 mm. horizontally and 10.3 mm. vertically, against 11.6 and 11 mm., respectively, in the normal eye). The predisposition to glaucoma is particularly marked in advanced age with the tendency toward abnormal growth of the lens. "It is well known," this author stated, "that glaucoma is more frequent in the short eye, and if to this is added an abnormally large lens, an increase in tension would be the natural consequence."

The relation between the internal capacity and the elasticity of the envelope of the eyeball, on the one hand, and the amount of its contents,

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56. von Graefe, cited by Fuchs,[60] p. 416.

57. Donders, cited by Fuchs,[60] p. 416.

58. Bowman, William: On Glaucomatous Affectations, and Their Treatment by Iridectomy, Brit. M. J. **2**:377, 1862.

59. Smith, Priestly: On the Shallow Anterior Chamber of Primary Glaucoma, Ophth. Rev. **6**:191, 1887; Tr. Internat. M. Cong., 1894, p. 33; Glaucoma: Pathogenesis, Symptoms, Causes and Treatment, in Norris, W. F., and Oliver, C. A.: System of Diseases of the Eye, Philadelphia, J. B. Lippincott Company, 1898, pp. 650-651.

on the other, has been suggested by Fuchs.[60] If the latter increases or the former diminishes, the pressure is elevated.

Stellwag von Carion [61] maintained that the rise of pressure is due to the increased blood pressure in the vessels of the interior of the eye in consequence of obstruction of their return circulation—venous stasis. The extended vessels fill a part of the cavity and press the fluid forward.

Salzmann [62] noticed that in glaucoma the lumen of the central vein is progressively narrowed down to complete occlusion.

Bartels [63] found narrowing of the interscleral section of the anterior ciliary arteries and expansion of the posterior ciliary arteries in glaucoma. He expressed the belief that in glaucoma the ocular blood vessels are frequently diseased. He questioned, however, if this is the original cause of the condition, because such changes in the blood vessels are also observed in arteriosclerosis.

Verhoeff [64] in ten cases of primary or secondary glaucoma found sclerosis of the ligamentum pectinatum, i. e., a general thickening of the network of the ligament, with new-formed tissue on its surface, dependent on a preceding anterior synechia which had been separated at the periphery.

Henderson [65] contended that the closure of the angle in primary glaucoma is caused by sclerosis of the sclerocorneal trabeculum. He noticed in occasional cases atrophy of the ligament epithelium at the iris and in some instances exfoliation of the lens and capsule.

Roemer [66] in a case of simple glaucoma observed sclerosis of the trabeculae and of the spaces of Fontana, with deposits of pigment.

VASCULAR CHANGES AS THE CAUSE OF GLAUCOMA

With the new conception of the permeability of the capillaries, the importance of vascular changes as a source of hypersecretion of fluids and colloids in the eyes has of late been brought to the fore.

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60. Fuchs, E.: Text Book of Ophthalmology, ed. 3, translated by Alexander Duane, Philadelphia, J. B. Lippincott Company, 1908, pp. 413-417.

61. Stellwag von Carion: Arch. f. Ophth. (pt. 2) **2**:202, 1874; cited by Fuchs,[60] p. 416.

62. Salzmann, M.: Die Ophthalmoskopie der Kammerbucht, Ztschr. f. Augenh. **31**:1, 1914; **34**:26, 1915.

63. Bartels, cited by Wood, C. A.: Eye, Ear, Nose and Throat, Practical Medicine Series, Chicago, Year Book Publishers, Inc., 1918, p. 103.

64. Verhoeff, F. H.: Histological Findings After Successful Sclerostomy, Arch. Ophth. **44**:129, 1915.

65. Henderson, F.: Glaucoma: An Inquiry into the Physiology and Pathology of Intra-Ocular Pressure, London, E. Arnold, 1910.

66. Roemer, cited by Elliot, R. H.: A Treatise on Glaucoma, London, Hodder & Stoughton, 1922, pp. 40, 51 and 71.

Starling demonstrated that lymph is formed in the tissues of the body by the process of filtration through the walls of the capillaries. According to Leber,[67] lymph infiltrated from the capillaries also forms the main source of ocular secretion. More recent observations in the study of physiology revealed that the lymph is a simple dialysate from the blood plasma. Duke-Elder has shown experimentally that the theory of dialysis holds true with regard to the ocular fluid. The difference in pressure which exists in the various tissues of the body is generally accepted to be influenced by the difference in the permeability of the capillary walls, which are the dialyzing membranes. The original energy influencing the pressure in the tissues of the body is derived from the general blood pressure affected by the action of the heart. Manometric observation indicated that changes in the intra-ocular pressure follow changes in the blood pressure. Duke-Elder estimated that the average pressure in the intra-ocular arteries is 88 mm. of mercury systolic and 64 mm. diastolic. The pressure of the internal carotid artery that supplies blood to the eye is a little less than that of the brachial artery, which is from 110 to 125 mm. systolic and from 60 to 80 mm. diastolic. The arteries of the eye which are under control of the vasoconstrictor fibers derived from the cervical portion of the sympathetic system are subject to variations in caliber, pressure and permeability and are of great importance in the study of glaucoma.

CHANGES IN THE TERMINAL VESSELS AS A CAUSE OF GLAUCOMA

As early as 1884 Birnbacher[68] attributed the hypertension to the damage done to the terminal vessels by the retardation of the venous circulation. He observed in glaucomatous eyes considerable cellular infiltration in and around the vessels and the lymph spaces. He also noted proliferation of the endothelium of the veins and congestion and swelling of the neighboring structure of the vessels.

Duke-Elder[69] observed dilatation and an increase of permeability of the minute vessels of the surface of the iris in glaucoma. He found that the protein of the aqueous which had escaped from the permeable vessels was at times sufficient to form a clot and block the canals. The same author intimated that the glaucomatous crisis might be produced

67. Leber, cited by Parsons, J. H.: Diseases of the Eye, ed. 8, New York, The Macmillan Company, 1936, p. 15.

68. Birnbacher, cited by Elliot, Robert Henry: Glaucoma, New York, Paul B. Hoeber, 1918, p. 101; cited by von Graefe, A.: Wundbehandlung bei Augen-Operationen mit besonderer Berücksichtigung der Staare-Extraction; Operation unreifer Staare, Arch. f. Ophth. (pt. 4) **30**:211, 1884.

69. Duke-Elder, S.: The Aetiology of Glaucoma, Tr. Ophth. Soc. U. Kingdom **53**:281, 1933. Duke-Elder, S., and Duke-Elder, P. M.: Etiology of Glaucoma, Arch. Ophth. **11**:49 (Jan.) 1934.

by the liberation of histamine-like bodies in the eye, caused by the destructive rise of pressure. He induced a vascular crisis in the eye of animals such as might result clinically in acute glaucoma by raising the intra-ocular pressure mechanically to a height above that of the ophthalmic artery.

Mészáros and Toth [70] found distinct changes in the structure and functions of the vessels and capillaries of glaucomatous patients. Primary glaucoma, in his opinion, is associated with pathologic changes of the vascular system.

Schmidt [71] in an analysis of thirty-four patients with glaucoma simplex found that thirty-three showed a disturbance of the capillary system throughout the body. The rise of pressure which occurred during the course of his experiments on glaucomatous eyes was accompanied by a local disorder of the capillaries on the same side. His conclusion agrees with the results of the studies of Friedenwald,[72] who found that acute glaucoma is regularly associated with vascular lesions localized in the capillaries.

Wegner [73] observed in 70 per cent of patients with chronic simple glaucoma a definite disturbance of the capillary endothelium throughout the body. He concluded that glaucoma is a general disease and not merely a local disturbance.

De Saint-Martin and Mériel [74] studied twenty-two consecutive patients with glaucoma with the oscillometer of Boulitte. All manifested a widespread vascular disorder. Similar obseravtions were made by Ferrari [75] and Troncoso.[76] The last suggested as a working hypothesis the assumption that simple glaucoma is a chronic vascular disease. He was of the opinion that only in the event of a permanent increase of capillary permeability accompanied by severe nervous and congestive

70. Mészáros, K., and Toth, Z.: Ueber das periphere Gefäss-system von Glaukomkranken, Klin. Monatsbl. f. Augenh. **90**:67 (Jan.) 1933.

71. Schmidt, K.: Klinische und experimentelle Studien über lokale und allgemeine Gefäss-störungen beim Glaukoma simplex, Arch. f. Augenh. **100-101**:190, 1929.

72. Friedenwald, Jonas S.: The Pathogenesis of Acute Glaucoma, Arch. Ophth. **3**:360 (May) 1930.

73. Wegner, Wilhelm: Ueber die Bedeutung des Flüssigkeitsaustausches zwischen Blut und Gewebe für das Glaukom, Arch. f. Augenh. **103**:511 (Dec.) 1930.

74. de Saint-Martin and Mériel, P.: Glaucome et tension moyenne, Arch. d'opht. **49**:705 (Nov.) 1932.

75. Ferrari, A.: Glaucoma primario e resistenza globulare media contributo alla conoscenza della morfofisiologia del sangue nel glaucoma, Arch. di ottal. **39**:147 (April) 1932.

76. Troncoso, M. U.: Patogenesis del glaucoma investigaciones clínicas y experimentales, An. de oftal. **4**:97, 135 and 167, 1901-1902.

symptoms does the pressure become permanently high. "Under such conditions," he added, "the colloids within the aqueous increase the tension by permanently closing the angle of the anterior chamber." Excavation of the disk and atrophy of the optic nerve take place, according to Troncoso, only when there is malnutrition of the retina and optic nerve.

Sondermann,[77] after an extensive study of the subject, suggested that four elements might be responsible for the pathogenesis of primary glaucoma: (1) the blood pressure in the capillaries of the uvea, (2) the osmotic blood pressure, (3) the amount of fluid entering the eye and (4) the degree of elimination of fluid from within the eye. "In advanced life," he maintained, "because of the increase of sclerosis of the sclera and the resultant increase of pressure in the vortex veins, there is an increase in the aqueous production as well as in its outflow." Glaucoma, according to Sondermann, depends on the rapidity of the sclerosing process in the sclera and the trabecula.

Tewbin and Wilensky[78] in the ophthalmic clinic of Moscow State University and the clinic of the Kasan State Institute observed during a period of ten years changes in the vascular system and in the capillary network in juvenile glaucoma.

RELATION OF GENERAL BLOOD PRESSURE AND INTRAOCULAR PRESSURE

The important part played by the systemic blood pressure on the intra-ocular hypertension has been stressed of late by many observers. Uyemura and Suganuma[79] with their newly devised instrument, the ophthalmodynamometer, determined that there is a decided relationship between the general blood pressure, the pressure in the retinal vessels and the intra-ocular pressure.

A similar conclusion was reached by Parson and by Jackson, Adler and Landis.[80] Their researches have shown that an increase in the general blood pressure produces a corresponding increase in the intra-

77. Sondermann, S.: Meine Glaukomtheorie und die Klinik des Glaukoms, Klin. Monatsbl. f. Augenh. **92**:313 (March) 1934.

78. Tewbin, B. G., and Wilensky, L. I.: Zur frage der Gefässdestruktion beim Glaukom des Jugendalters, Ztschr. f. Augenh. **80**:141 (April) 1933.

79. Uyemura, M., and Suganuma, S.: Ueber einen neuen Ophthalmodynamometer, Klin. Monatsbl. f. Augenh. **96**:481 (April) 1936. Suganuma, S.: Studien über den Blutdruck in der Zentralarterie der Netzhaut; über den Blutdruck in der Zentralarterie der Netzhaut bei gesunden Menschen und über seine Beziehung zum allgemeinen Blutdruck, ibid. **96**:74 (Jan.) 1936.

80. Jackson, C. L.; Adler, F. H., and Landis, E. M.: Tonic Effect of Sympathetic on Ocular Blood Vessels, Arch. Ophth. **53**:239 (May) 1924.

ocular pressure. A sudden harmful increase is prevented by the local vasoconstrictor fibers through the cervical portion of the sympathetic nervous system. Vele [81] maintained that the systolic and diastolic blood pressures are higher in glaucomatous patients than in normal persons.

On the other hand, the investigation of Seidel did not reveal any marked relation between the general blood pressure and the intra-ocular pressure.

Hertel [82] showed that an increase in the systemic blood pressure affects the eye only when it comes on suddenly. Otherwise its action is not necessarily marked.

Similar conclusions were reached by Weinstein,[83] whose observation of three hundred selected glaucomatous patients indicated that while there was some rise in the general blood pressure, the increase was not of such an extent as to be considered pathognomonic of glaucoma.

Block and Oppenheimer [84] found no apparent relationship between the intracranial pressure and the intra-ocular tension.

SYMPATHETIC NERVOUS SYSTEM, A REGULATOR OF OCULAR TENSION

Far back in 1727, in the time of Pourfour-du-Petit, it was observed that after excision of the cervical portion of the sympathetic nervous system the eye became softer. This condition was attributed by Abadie to the stimulation of the vasodilator fibers of the ocular blood vessels, and he suggested (1898) section of the sympathetic nervous system for relief of the tension. Resection of the superior ganglion of the cervical portion of the sympathetic nervous system was soon after performed by Jonnesco; this proved successful in reducing the tension.[85]

In 1898 Abadie [86] showed that one of the functions of the sympathetic nervous system is to regulate the tension of the intra-ocular fluid.

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81. Vele, M.: Sui rapporti tra arteriosclerosi e glaucoma, Ann. di ottal. e clin. ocul. **61**:511 (July) 1933.

82. Hertel, E., cited by Cordes, F. C.: Early Simple Glaucoma: Its Diagnosis and Management, Arch. Ophth. **17**:896 (May) 1937.

83. Weinstein, P.: The Relationship Between Glaucoma and Cardio-Vascular System, Orvosképzés **24**:632, 1934.

84. Block, E. B., and Oppenheimer, R. H.: Comparative Study of Intraspinal Pressure, Blood Pressure and Intra-Ocular Tension, Arch. Neurol. & Psychiat. **11**:444 (April) 1924.

85. Jonnesco, cited by de Schweinitz, G. E.: The Physiology of the Sympathetic in Relation to the Eye, in the Relation of the Cervical Sympathetic to the Eye, papers read before the Section on Ophthalmology of the American Medical Association at the Annual Session, New Orleans, May 1903, Chicago, American Medical Association Press, 1904, p. 21.

86. Abadie, C.: Considérations sur la pathologie du grand sympathique, Clin. opht. **27**:303, 1923.

Soon after, Weeks [87] collected data for four cases of simple chronic glaucoma. In two the superior ganglion on one side of the neck was removed, and in the other two both superior ganglions were excised. All the patients showed a moderate degree of tension.

Four years later, Henderson and Starling [88] demonstrated that the sympathetic nervous system possesses vasoconstrictor fibers which terminate in the uveal blood vessels, stimulation of which causes constriction of the intra-ocular blood vessels.

The experiments of Bistis [89] on rabbits (1913), however, revealed that the function of the sympathetic nervous system in regulating the ocular tension is not decisive. He found that its action was only temporary. He concluded that it might be the first step in the development of glaucoma, provided a suitable terrain was present, such as rigidity of the sclera, errors of refraction, arteriosclerosis or an endocrine disorder.

There is no question, however, that a nervous element is associated with the increase of tension. I have frequently observed marked reduction in the intra-ocular tension in cases of accommodative strain which became normal after the refractive error was corrected. It has also been observed that emotion and nervous excitement predispose one to attacks of glaucoma and that there is a tendency for the disease to prevail in certain neurotic families and races.

GLANDULAR DYSFUNCTION AS A CAUSE

The theory of Heidenbein that the fluids of the body, including the lymph, are furnished by the glands prompted many observers to ascribe glaucoma to a glandular dysfunction. It is well known that stimulation of the secretory nerves of the salivary glands produces saliva at a rate far exceeding that of the intra-ocular secretion.

Hertel [90] expressed the belief that hypersecretion in glaucoma is associated with dysfunction of the thyroid. He observed that extirpation of the thyroid caused an increase of intra-ocular pressure, while the administration of thyroid produced a drop in the intra-ocular tension.

The results of Mossa's [91] studies of the influence of the glands on the intra-ocular tension confirmed the opinion of Hertel with regard to the

87. Weeks, John E.: Cases of Simple Chronic Glaucoma Treated by Resection of the Superior Ganglion of the Cervical Sympathetic, Tr. Am. Ophth. Soc. **9**:441, 1902.

88. Henderson, E. E., and Starling, E. H.: The Influence of Changes in the Intra-Ocular Circulation on the Intra-Ocular Pressure, J. Physiol. **31**:305, 1904.

89. Bistis, J.: The Role of the Sympathetic in Glaucoma, Arch. d'opht. **47**:96 (Feb.) 1930.

90. Hertel, E.: Experimentelle Untersuchungen über die Abhängigkeit des Augendrucks von der Blutgeschaffenheit, Arch. f. Ophth. **88**:197, 1914.

91. Mossa, G.: Influenza di alcuni estratti ghiandolari, Rassegna ital. d'ottal. **3**:28 (Jan.-Feb.) 1934.

thyroid glands, but disagreed with the view that other glands have a disturbing influence on the ocular secretion.

Fuchs [92] and Lamb [93] maintained that the excess of fluid in glaucoma is due to the action of the glands of internal secretion. These glands, they asserted, have an effect on the vascular system, which, in turn, regulates the amount of the intra-ocular fluid.

It is significant that most investigators stressed the origin of the ocular fluid as though it were a question of hypersecretion only. They did not take into account the fact that the outflow mechanism of the eye can take care not only of the normal secretion but also of any extra increase. It is well known that if a few drops of fluid are injected into the anterior chamber of a normal eye, the hypertension momentarily caused will soon return to normal; the amount of extra fluid that has entered the eye will soon be balanced by a corresponding increase in the outflow through the excretory channels.

It was demonstrated that the flow through Schlemm's canal, the spaces of Fontana and superior ciliary vein is able to take care of all changes that may occur in the general arterial or venous pressure. Friedenwald and Pierce [55] proved that the outflow mechanism of Schlemm's canal can take care of ten times the normal circulation with a rise in the intra-ocular pressure of only a few millimeters of mercury. Hence too much stress cannot be laid on hypersecretion as the cause of glaucoma. The increased flow of lymph appears to be the result of glaucoma rather than the cause of it.

The theory that has received universal recognition is that of retention. This depends on the obstruction of the outflow of fluid from the eye by interference with its escape at the filtration angle.

Following the discovery of Leber [94] (1873) that the ocular fluid is drained from the eye through the sinus at the angle of the anterior chamber, Knies [95] (1876) and Weber [38b] (1877) independently observed closure of the sinus in enucleated eyes from glaucomatous patients, which they proclaimed as the initial cause of all the symptoms of glaucoma. Knies expressed the view that the closure that he observed was due to inflammatory changes in the vicinity of the trabeculum and in the canal of Schlemm, while Weber believed that the closure in his case was caused by a swollen ciliary process which pushed the iris forward through the corneoscleral aperture.

92. Fuchs, A.: Glaucoma, Bull. Ophth. Soc. Egypt, 1924, p. 23.

93. Lamb, R. S.: Glaucoma, Tr. Am. Ophth. Soc. **24**:105, 1926.

94. Leber, T.: Studien über den Flüssigkeitswechsel im Auge, Arch. f. Ophth. (pt. 2) **19**:87, 1873; in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, Leipzig, Wilhelm Engelmann, 1874, vol. 2, pt. 1, p. 302.

95. Knies, Max: Ueber das Glaucom, Arch. f. Ophth. (pt. 3) **22**:163, 1876; (pt. 2) **23**:62, 1877.

Although the discovery of Knies and Weber has been demonstrated both clinically and experimentally, the subject still remains a matter of controversy not only with regard to the original cause but also as concerns its influence on the intra-ocular pressure.

Fig. 8.—Photomicrograph of the angle of the anterior chamber in a healthy eye, showing the canal of Schlemm and the ligamentum pectinatum, with lymphatic crypts at the periphery of the iris. (After Collins, in Wood, Casey A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 5434.)

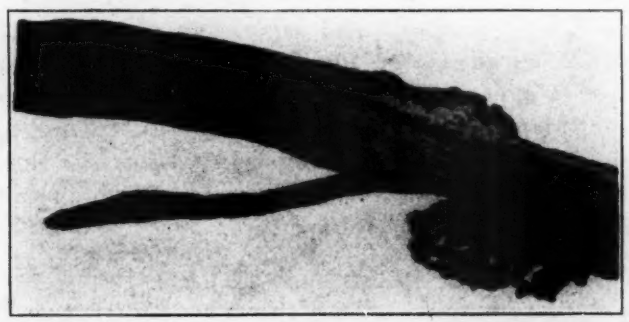

Fig. 9.—Photomicrograph of the anterior chamber of the eye in a case of primary glaucoma, showing the closure of the filtration area at the periphery of the cornea by adhesion to the root of the iris. (After Collins, in Wood, Casey A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 5438.)

Hugo Tailor, in collaboration with the celebrated Italian ophthalmologist, De Vincentiis (1893), claimed that there is a direct relation between closure of Schlemm's canal and simple glaucoma.[96] These authors succeeded in reducing the ocular pressure by opening the canal of Schlemm.

De Wecker was similarly convinced that opening of the canal would reduce the intra-ocular pressure, and he strongly urged this surgical method. Recently, Barkan [97] in a paper read before the American Academy of Ophthalmology and Otolaryngology in New York strongly advocated the removal of the obstruction by opening the canal of Schlemm under direct vision made possible by his slit lamp biomicroscopy. He was of the opinion that the pressure can be brought down to normal in the largest number of cases. On the other hand, the investigations of Saltzmann, Werner,[98] Thorburn [99] and Troncoso have shown that the angle is not always closed in glaucoma, and that in the primary form of the disease it is, as a rule, entirely or partly open.

Troncoso, who studied the different stages of the disease in the living eye with the gonioscope, denied that closure of the angle is the cause of simple glaucoma. He found a lack of correspondence between the height of the ocular pressure and the condition of the angle. "There might be," he stated, "an open angle and a pressure as high as 50 mm. Hg or more." He has shown that even when the entire angle around the limbus is obliterated by an anterior synechia, the pressure may be reduced by iridectomy without opening of the angle, for the escape of the ocular fluid does not entirely depend on Schlemm's canal and the spaces of Fontana. It is also drained off by the anterior ciliary vein and the anterior surface of the iris. Troncoso [53] concluded that at the beginning of the disease, when the attack is not severe, the angle is always open; if the attack persists, the angle may be partially closed, and in severe cases it may be closed all around.

Parsons,[100] who participated in the discussion of Barkan's paper at the meeting of the American Academy of Ophthalmology and Otolaryngology, remarked: "I would like to say, however, that I do not think that all cases of glaucoma are this type at all. I think there are cases

96. Tailor, U.: Sulla incisione del tessuto dell'angolo irideo (contribuzione alla cura del glaucoma), Ann. di ottal. **20**:117, 1891-1892. De Vincentiis: Incisione dell'angolo irideo nel glaucoma, ibid. **22**:540, 1893.

97 Barkan, Otto: Recent Advancement on the Surgery of Chronic Glaucoma, Tr. Am. Acad. Ophth. **41**:469, 1936.

98. Werner, S.: Gonioskopie Untersuchungen bei Glaucoma primarium, Acta ophth. **10**:427, 1932.

99. Thorburn, A.: Gonioscopical Study on Anterior Peripheral Synechia in Glaucoma, Dissert., Stockholm, 1927; cited by Troncoso,[53] p. 561.

100. Parsons, J. H., in discussion on Barkan,[97] pp. 486-487.

of glaucoma in which there is probably blockage of the angle of the anterior chamber, but the cause is such that the mere opening of the anterior chamber by any mechanical means is probably doomed to failure. We have to get further down into the root of the matter."

The blockage of the angle of the anterior chamber by small, dark, pigmented particles has been observed by many investigators. Koeppe [101] in 1916 noticed, with the slit lamp of Gullstrand, that in 80 per cent of cases of acute or chronic primary inflammatory glaucoma disintegration of the pigment epithelia ensued. The pigment appeared as small, dark, coarse particles floating about freely in the aqueous. These also attacked the ciliary body of the iris, the capsules of the lens, the marginal portion of the cornea, the lymphatic spaces and the sheets of the lymphatic vessels. The presence of granules of pigment in the eye was considered by Koeppe to be pathognomonic of primary glaucoma. Because of their coarseness they obstructed the lymph channels and blocked the outflow of the aqueous.

The presence of granules of pigment blocking the pores of the trabeculum and their effect on the rise of tension were also observed by Barkan.[97]

Greeves [102] noticed in a group of cases of glaucoma that the spaces of Fontana were blocked by large swollen cells apparently phagocytic in nature.

The presence of pigment deposits is most likely caused by sclerosis or by atrophic changes of the pigment epithelium of the iris and capsules of the lens. Operative intervention in cases in which the pores of the trabeculum are closed with granules of pigment will probably be of no permanent benefit, since their presence in the aqueous will soon block the channels again. Deposits of pigment in the eye can scarcely be the original cause of glaucoma, since they are frequently observed in healthy eyes of the aged. The correlation lies in the fact that deposits of pigment, as well as glaucoma, are coincident with the degenerative changes characteristic of old age. Their presence, however, should be looked on with suspicion as a prodrome of glaucoma.

Meesmann [103] and Biffis [104] maintained that alkalinity of the blood leads to glaucoma. The presence of superabundance of protein in the

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101. Koeppe, L.: Die Rolle des Irispigments beim Glaukom, Ber. ü. d. Versamml. d. ophth. Gesellsch. **40**:478, 1916.

102. Greeves, R. A.: Case of Partial Oculomotor Paralysis, with Synchronous Clonic Contractions of Muscles Supplied by the Third Cranical Nerve, Proc. Roy. Soc. Med. (Ophth. Sect.) **6**:23, 1912-1913.

103. Meesmann: Alkalinity of the Blood and Intra-Ocular Pressure, Russk. arch. oftal. **7**:786 (July) 1930.

104. Biffis, A.: L'alcalescenza del sangue nei glaucomatosi, Ann. di ottal. e clin. ocul. **61**:109 (Feb.) 1933.

ocular fluid was suggested by Duke-Elder and other investigators as a possible cause of glaucoma.

Fischer and Thomas [105] ascribed the etiology of glaucoma to chemical changes in the tissue of the eye itself whereby certain substances (particularly acid) capable of increasing the affinity of the colloids of the tissue for a larger amount of water were formed. Their theory differs from that of hypersecretion in the fact that it maintains that the ocular fluid does not originate in the blood vessels, lymph spaces or ciliary body but is due to the changes occurring in the intra-ocular contents which causes an increased amount of water to be absorbed. Thomas found that a subconjunctival injection of sodium citrate neutralized the effect of the acid in the contents of the eye and causes the tension to decline.

SUMMARY AND CONCLUSIONS

In reviewing the history of glaucoma one is impressed with the fact that throughout the ages this disease has presented a difficult problem the solution of which engaged the serious attention of the physician of ancient times as it does that of the modern student of ophthalmology. The tremendous amount of research done within the last hundred years to discover the etiology of the disease has disclosed many pathologic conditions, some of which are sequels or intermediate causes. Others are symptoms and form a part of the syndrome by which glaucoma is recognized. The original cause of primary glaucoma, however, still remains a problem.

Years ago, when the diseases of the eye were still in the province of the general practitioner, glaucoma was considered a local manifestation of a constitutional disorder, as albuminuric retinitis and diabetic retinitis are now considered. Gout, rheumatism, arthritis or some other condition was taken to be the original cause. The treatment was directed at the original cause, and the name and classification of the disease were based on its etiology, viz., arthritis ophthalmia, gouty ophthalmia and rheumatic ophthalmia.

With the invention of the ophthalmoscope the attention of the ophthalmic surgeon, with few exceptions, was focused on the eye as an independent unit. The numberless theories proposed to explain the original cause of glaucoma were confined to the eye. They proved to be, however, explanations of the exciting cause rather than of the original etiology, and the course of treatment, both medical and surgical, was directed to abate the troublesome symptoms rather than to combat the original cause.

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105. Fischer, M. H.: Ueber Hornhauttrübungen, Arch. f. d. ges. Physiol. **127**: 46, 1909. Thomas, H. G., and Fischer, M. H.: The Relief of Glaucoma Through Subconjunctival Injection of Sodium Citrate, Ann. Ophth. **19**:40, 1910; cited by Ball, J. M.: Modern Ophthalmology, Philadelphia, F. A. Davis Company, 1913, p. 563.

The name glaucoma has become a meaningless label, since ophthalmologists no longer recognize the color of the pupil as of diagnostic importance. The classification of the disease as taught in the textbooks is doubly misleading, as the term primary, which signifies first in origin and implies that the excess of fluid in the eye arises without any antecedent cause, is contrary to the very conception of physical science. Indeed, since the use of the slit lamp, in one half of the cases of apparently simple glaucoma the condition is recognized as having an inflammatory basis by deposits seen on the posterior surface of the cornea and over the iris and lens. According to Redslob,[106] glaucoma, in all cases, is secondary. "If it does not occur as a sequel to iridocyclitis and if it is not caused by lenticular changes or by tumors, it is secondary to intra-ocular circulatory disturbance."

The conclusion to be drawn from the discussion is that primary glaucoma must be looked on as an ocular complication of some organic or constitutional disease the nature of which is still unknown. The fact, however, that the disease is almost always associated with advanced age offers a clue that the etiology is bound up with the wear and tear of the body which accompany the declining years of life.[107]

Since the most frequent degenerative change of old age is arteriosclerosis, primary glaucoma may be related to pathologic changes in the vascular structure of the body. Such changes in the larger vessels and capillaries were found in patients of the age when primary glaucoma is frequent. The pathologic changes consisted of retardation of the general venous circulation and cellular infiltration in and around the capillaries and lymph spaces. Vascular changes are particularly apparent in the eye, principally in the ciliary process, which is rich in terminal veins.

In glaucoma the veins are particularly affected. The disease is more frequent among women than among men, since the former are more liable to venous congestion. I have noticed also a striking association between varicose veins and glaucoma among male patients.

The damage done to the venous circulation causes hypersecretion of the ocular fluid, and the venous stasis causes swelling of the ciliary processes, which results in narrow[illegible] circumlental space and the subsequent blocking of all communication between the vitreous and the anterior chamber.

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106. Redslob, E.: Le glaucome primitif est-il une affection inflammatoire? Ann. d'ocul. **172**:1 (Jan.) 1935.

107. Knapp, Herman: Caries and Necrosis of the Walls of the Orbit, Tr. Am. Ophth. Soc., 1889, p. 319. Zentmayer, W., and Posey, W. C.: A Clinical Study of One Hundred and Sixty-Seven Cases of Glaucoma Simplex, Arch. Ophth. **24**:378, 1895.

Some observers have noticed sclerosis of the trabeculum and thickening of the ligamentum pectinatum, which resulted in the obstruction of Schlemm's canal and the spaces of Fontana.

Other pathologic conditions of the eye which are characteristic of old age are the presence of deposits of colloid and pigment on Descemet's membrane, the anterior capsule of the lens, the vitreous and the lamella of the choroid. Such deposits are particularly frequent in glaucomatous eyes. They have been noticed in the spaces of Fontana and in Schlemm's canal. In some cases they blocked the drainage of the ocular fluid.

But while in all probability arteriosclerosis is at the basis of the disease, a glaucomatous attack is precipitated only when the resistance of the aged is weakened by disease and by physical and mental strain.

Lagrange, who is best known for his surgical devices for the relief of hypertension, struck the right chord when he stated, "The eye attacked by hypertension is a sick eye in a sick body and is not merely a hypotonic organ but also a sclerosed, dystrophic organ that shares the trouble with the rest of the body."

INTRACAPSULAR CATARACT EXTRACTION

REPORT OF A FURTHER SERIES OF CASES

LEIGHTON F. APPLEMAN, M.D.

PHILADELPHIA

The purpose of this paper is to report the results of my experience with intracapsular cataract extraction in a third series of cases, covering the period from my last report, March 1935, to November 1937. This series includes 268 cases from the wards of the Wills Hospital, in 250 of which there were no complications and in 18 of which complications were present, and 72 cases from private practice.

The Knapp method was used in all cases, as it is, in my opinion, one of the simplest methods and the freest from all unnecessary details for its accomplishment.

The beginner in the practice of ophthalmology who is fortunate enough to observe the results of various types of operation for cataract will select that method which appeals to him most strongly. The repetition of the same technic will render the operator proficient in its performance.

In spite of the fact that a description of the technic may seem trite to the experienced operator, for the benefit of those beginning the study of ophthalmology, and in the hope that instructive criticisms or experiences with other methods may be brought out, I shall repeat it.

TECHNIC OF OPERATION

After the production of akinesia to prevent spasm of the orbicularis muscle and the administration of a solution of atropine to dilate the pupil, corneal section is made as nearly through the limbus as possible, with no, or with a very narrow, conjunctival flap. The more I use this incision the better I like it, as little or no bleeding occurs to flood the anterior chamber and healing is perfectly smooth if care is taken with the toilet of the wound at the end of the operation to guard against shreds of iris tissue, conjunctiva and blood clots being included in the wound.

Iridectomy is then done, the iris being grasped near its free border, withdrawn and cut with the blade of the iris scissors held at right angles to the wound. This will give a small narrow space, sufficient for the free passage of the lens, and it will be less likely to cause the patient annoyance from glare than a large coloboma. I mention this because it not infrequently happens that a resident, working under my direction, is inclined to cut with the scissors blade parallel with the wound,

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Read before the Section on Ophthalmology, College of Physicians of Philadelphia, Dec. 16, 1937.

which, with the iris drawn well out, will give a broad coloboma, such as is desired in operations for glaucoma but which is unnecessary for cataract extraction and very annoying to the patient subsequently on account of glare.

Should bleeding occur after iridectomy the anterior chamber should be flushed out at once and bleeding allowed to cease before one proceeds, in order that one may see and control the grasp of the forceps on the capsule.

With the Arruga or the Kalt forceps, the capsule is grasped in its lower third if possible, and gentle traction is exerted upward and forward and from side to side until the zonule ruptures below and the equator of the lens presents in the pupillary space. At this time it is my custom to let go of the capsule and to grasp a slightly curved spoon in each hand; the lower spoon is used to make pressure on the cornea below the lower equator of the lens causing it to rotate upward or tumble, and at the same time the spoon in the left hand is used to make slight downward pressure near the edge of the upper lip of the wound as the lens presents. Following the lens upward by an even pressure from below causes it to be delivered without difficulty as a rule.

Some operators, instead of relinquishing the grasp on the capsule, draw the lens upward and out at once. This is a point in technic which will be entirely a matter of individual preference. To me it would seem awkward, and should the capsule tear in delivery it would seem more difficult to get rid of the freed cortex and the remainder of the capsule.

After delivery of the lens, careful reposition of the iris is done, the operator stroking downward but not too deeply, to free the pillars of the iris, and then upward to clear the lips of the wound. The eye is closed after a drop of atropine solution is instilled.

In attempting this type of operation, one has the satisfaction of knowing that if the capsule tears before the zonule is broken, a considerable portion of the anterior capsule is removed in the grasp of the forceps, and the procedure may then be completed as in the older, classic type of operation. In this case an irrigator should be used to flush out as much cortical remains as possible.

With increasing experience, one can often determine the probability of seizing the capsule, although this is not always possible. The intumescent mother-of-pearl type of cataract usually cannot be grasped, although there is no reason why an attempt should not be made.

The intracapsular operation is particularly desirable in cases of nuclear and incomplete cortical cataract in which with the older technic it is difficult to get rid of soft and often sticky cortical substance by irrigation. A mature cataract can be removed readily after the stage of primary swelling, as can be judged by direct examination and by the depth of the anterior chamber. The use of the intracapsular operation is questionable for patients with very prominent eyeballs but without myopia of a high degree, as for them the danger of loss of vitreous is greater, especially if they do not give perfect cooperation. The same may be said, but with greater emphasis, about patients with a high degree of myopia, as the vitreous may be fluid and other changes may be present in the deeper structures. The use of the operation is also questionable for persons with only one eye, particularly elderly persons in whom

there may be arterial changes which predispose to hemorrhage, and for patients with cardiorenal vascular disease. I do not hesitate to attempt intracapsular extraction on persons with diabetes, after a check-up on the blood sugar and its reduction to normal range.

Cataracts associated with evidences of preceding iritis or iridocyclitis are usually not amenable to removal by the intracapsular method. They may have a very dense capsule due to the deposition of inflammatory products. In such cases the amount of traction necessary to break the zonule may do damage to the deeper structures of the uveal tract; such traction had better be discontinued and a cystotome employed, followed by expression of the cataract and irrigation.

I have had no experience with conjunctival flap sutures, corneal sutures or rectus muscle stay sutures. They would complicate the technic for me.

RESULTS

The following results were obtained in my third series of cases:

In 146, or 58.4 per cent, of the 250 cases in which there were no complications the intracapsular method was performed, either by my assistants, the resident or myself. Vision of 6/12 or better was obtained in 98 cases, or 67.1 per cent, as follows: vision of 6/6 in 37 cases, vision of 6/9 in 38 cases and vision of 6/12 in 23 cases. These results would have been better if all the patients had returned for a check-up; about 56 did not return after leaving the hospital, probably because they lived at a distance or on account of the infirmities of age, and therefore their results are those recorded just before discharge.

In 104 of the 250 cases the classic method of operation was used. Vision of 6/12 or better was obtained in 80 cases, or 77 per cent, as follows: vision of 6/6 in 20 cases, vision of 6/9 in 44 cases and vision of 6/12 in 16 cases.

In the 72 cases from private practice in which the intracapsular method was used, vision of 6/12 or better was obtained in 63, or 87.5 per cent, as follows: vision of 6/6 in 42 cases, vision of 6/9 in 20 cases and vision of 6/12 in 1 case. An expulsive hemorrhage occurred in 1 case, with loss of the eye.

Dr. Robb McDonald, the present senior resident at the Wills Hospital, in collaboration with Dr. Alfred Cowan in a study of the late results of various types of cataract operations, called in many patients who had been operated on from one to four years previously to determine the condition of the eyes after those intervals. Of 52 eyes examined on which intracapsular extraction was done, there was an improvement in vision over that last recorded in 22; vision was unchanged in 18 and was slightly less in 12.

In addition to the 250 cases in which there were no complications, there were 18 cases in which the outcome was quite different. The

intracapsular operation was performed in 13 of these and was considered a failure in 12 because of the following complications: iridocyclitis, ending in phthisis bulbi, 2 cases; hemorrhage, due to the patient getting up shortly after operation, followed by panophthalmitis, necessitating enucleation, 2 cases; detachment of the retina, 1 case; detachment of the choroid, 1 case (reattachment occurred later but the visual result was not recorded); macular choroiditis, 1 case; chronic glaucoma, 1 case; cardiac failure, with sudden death, 2 cases (in 1 four days after operation and in the other twelve days after operation), the eye being in good condition, and loss of considerable vitreous, 2 cases. The patient in 1 of the last 2 cases did not report again after discharge, and the other, a deaf person, could not hear well enough to cooperate properly. In the additional case the patient, a man of 86, was lost from observation, and vision was not recorded.

The extracapsular extraction was performed in 5 cases and was considered a failure because of the following complications: iridocyclitis, 1 case; central retinochoroiditis, 1 case; optic atrophy secondary to cataract with secondary glaucoma, 2 cases, and chronic myocarditis, with sudden death eleven days after operation, the eye being in good condition, 1 case.

Personally, the intracapsular operation is the method of choice in cases in which there are no complications because of the smoothness and rapidity of convalescence, the absence of reaction and the visual results obtained. At the first dressing, forty-eight hours after the operation, the eye usually shows scarcely any reaction, the pupil is clear and the eye remains quiet throughout convalescence. The patient can be discharged as early as the eighth day in many instances and has the satisfaction of knowing that no further operation is necessary.

From a review of the three series of cases reported since I began to use the intracapsular procedure, I find that the following visual results were obtained: In the first series of cases, reported Nov. 17, 1932, 67.02 per cent of the patients obtained vision of 6/12 or better.[1] In the second series of cases, reported March 21, 1935, 77 per cent of the patients obtained vision of 6/12 or better.[2] In the present series of cases 70.7 per cent of the patients in the ward and 87.5 per cent of the private patients obtained vision of 6/12 or better.

I consider these results very satisfactory, especially in view of the fact that a great many of the patients in the ward were poor surgical risks.

308 South Sixteenth Street.

1. Appleman, Leighton, F.: Intracapsular Cataract Extraction by the Knapp Method: A Report of One Hundred Cases, Arch. Ophth. **9**:907 (June) 1933.

2. Appleman, Leighton F.: Intracapsular Cataract Extraction by the Knapp Method as Compared with the Classic Procedure: A Further Report, Arch. Ophth. **14**:249 (Aug.) 1935.

DISCUSSION

DR. ROBB MCDONALD: I should like to say a few words about the investigation which Dr. Cowan and I have been carrying out and to which Dr. Appleman referred in his paper. We are interested in the changes in the anterior segment of the eye as examined under the slit lamp and the changes in visual acuity several years after the operation. Letters were sent to 750 patients who had undergone operations for cataract at the Wills Hospital during the period from 1933 to 1935. All patients with traumatic cataract, cataract with complications and cataract associated with glaucoma and those patients known to have lesions in the posterior segment of the eye were excluded from the series. The response from the patients was poor, and we have examined only 156 aphakic eyes. This study included an examination with the slit lamp and refraction.

When we have investigated an additional series of patients our findings will be reported in full and more definite conclusions can be made, but for the present our conclusions are as follows:

1. After intracapsular extraction for cataract the hyaloid membrane bulges forward into the anterior chamber for the first few weeks; later it becomes flatter and does not protrude through the pupillary space. In many cases there is a rent in the hyaloid membrane, with subsequent herniation of vitreous into the anterior chamber. In such cases the vision did not appear to be affected.

2. In the aphakic eyes which had been subjected to intracapsular extraction no changes were found in the hyaloid membrane suggestive of increasing density of the membrane or of its becoming less transparent. In fact, in most cases the visual acuity was the same or better than that found at the original refraction.

3. An incision which is limbal throughout gives a better healing scar than one which is further forward on the cornea.

In those cases in which preliminary iridectomy was performed there were far fewer incarcerations of the pillars or anterior or posterior synechia (in extracapsular extractions) of one or both pillars.

4. The appearance of the capsule at extracapsular extraction is no index of what the visual acuity may be. In many cases slit-lamp examination showed the pupillary space to be filled with clusters of Elschnig bodies and strands of opaque capsule, yet on refraction nearly normal or normal vision was obtainable.

5. So far in our investigation we have found slightly better vision in those eyes subjected to intracapsular extraction than in those subjected to extracapsular extraction.

DR. EDWARD BEDROSSIAN: In two of the five medical mission hospitals in India where I served as associate ophthalmologist last year the intracapsular method of cataract extraction was used as a routine operation.

The first problem was the selection of proper subjects for this type of extraction. All those with juvenile cataract, prominent eyes (called ox eyes in India), cataract complicated with uveitis, synechiae, discoloration or ectasia of the sclera, or cataract associated with glaucoma were excluded.

Secondary glaucoma due to hypermature cataract was extremely common. Many patients were totally blind in both eyes on account of hypermature cataract with absolute glaucoma.

In Lalitpur my associates and I employed Sir Henry Holland's technic, with the addition of the O'Brien method for paralysis of the orbicularis muscle. Tension of all eyes was taken twice at the operating table with the Schiötz tonometer as a routine measure, and if tension was found to be above 25 mm. of mercury, the patient was considered unsuitable for intracapsular extraction; with from 10 to 50 patients with cataract reporting daily for operation, there were still plenty on whom the intracapsular method could be performed.

With this method, after limbal incision and the usual iridectomy are carried out, the eyelid speculum is removed, and the patient is told to look straight up. The upper lid is lifted away from the eyeball by a broad lid elevator and held in this position by the assistant. While the patient looks straight up, the eyeball is steadied with a small oval spatula applied below the limbus, and the zonule is broken at the lower limbus by gentle stroking with the Smith hook. This makes the lens tumble and come out without the use or aid of the capsule forceps. Occasional loss of vitreous is due to the patient's looking down instead of straight up during the extraction of the lens or toilet of the wound. When the extracted lens jams in the upper fornix, it is easily removed with a small spoon or spatula. After reposition of the pillars of the iris and toilet of the wound, a dressing moistened with mercury bichloride in a concentration of 1 : 2,000 is used.

In Coinbatore, Dr. S. Qurubatham has developed a very complicated and elaborate technic of his own which is quite different from that described.

As a routine procedure, he injects pontocaine in a concentration of 1 : 500 into the orbicularis muscle and the ciliary ganglion. Epinephrine is injected subconjunctivally, the pupil is dilated with homatropine, the superior rectus suture is used to rotate the eyeball downward and the assistant holds it in the most desirable position throughout the operation. He finishes his limbal incision with a small conjunctival flap. If the lens and vitreous move forward toward the incision, he uses a flap suture before extraction. He breaks the zonule with the Smith hook at the lower limbus, and then with his own special capsule forceps pulls the lens out with great care through the intact pupil. After reposition of the iris and careful toilet of the wound, he reflects the conjunctival flap backward, and with a Barraquet iris forceps and iris scissors performs a small peripheral iridectomy. Peripheral iridectomy after simple extraction checks the danger of postoperative prolapse of the iris into the incision.

His handling of the eye is so masterly and gentle that there is hardly any traumatism. On the third day, when the dressing is changed and the eye inspected, there is a rapidly healing wound in perfect apposition and a clear round pupil.

I had seen simple extracapsular extractions followed by peripheral iridectomy performed at Moorfields in London and elsewhere, but I had never seen the elaborate intracapsular technic of simple extraction which gave such excellent results in Dr. Qurubatham's skilful hands.

Whether in Europe, in India or in America, I feel that intracapsular extraction in all selected cases in well trained hands should be the

operation of choice, and I admire the remarkable ease and skill with which Dr. Appleman performs this operation.

Dr. George Cross: It has been interesting and instructive to hear this excellent paper, and I hope that Dr. Appleman will report the results obtained in his next series of cases.

In May 1929 I started using the intracapsular method of cataract extraction, following the Knapp-Török-Stanculeanu technic. I am still using it and am quite enthusiastic about it. I know that Dr. Appleman does not favor the use of conjunctival flaps. I do, and I feel much safer when, in addition to operating in selected cases, I suture the flap down. It is a part of my routine to do a peripheral button hole iridectomy for many reasons. I think that many operators do not do this because of the difficulty in grasping the iris properly. This is overcome by the use of the Hess forceps.

Loss of vitreous can be avoided at times by the use of more pull and less push in rupturing the zonula and by tending to preserve the hyaloid membrane. If after the zonula is ruptured the lens is soft and tends to assume a spherical shape, I do not let go the capsule but deliver it without further manipulation.

Retrobulbar or muscle cone injection of procaine hydrochloride is of great value in my hands. Since the visit of Dr. Arruga to Dr. Shannon's clinic at the Jefferson Hospital, I purchased his specula and have been suturing the superior rectus muscle tightly to hook on the upper bar, and so far I am greatly pleased with the results obtained.

I was interested in reading some time ago a statement by Dr. A. Fuchs about the danger of leaving a stringy fiber of cotton in the eye.

I still believe that the younger operators should perfect the extracapsular technic first and then when proficient select cases in which to use special methods.

Dr. Edmund B. Spaeth: In regard to releasing the capsule forceps, many authorities have suggested that patients with cataract be divided into two groups. The first group is made up of those suspected of having a fluid vitreous. In operating on such patients it is suggested that the hold of the capsule forceps be maintained and be used to aid in pulling out the lens. The second group consists of persons considered to have a healthy vitreous. In operating on these patients it is suggested that the forceps be released and the lens expressed with spoon and hook, thus making use of the hydrostatic state of the vitreous.

Dr. Appleman: The delivery of the lens by pressure or traction can be done with equal facility by individual operators who are experienced. One must quickly determine which method is best in the given case.

Regarding the use of a cotton-wrapped applicator in cleansing the débris from the site of operation, it is preferable to moisten the cotton slightly before use in order to prevent loose strands becoming entangled in the wound and inducing or favoring secondary infection during healing.

As to iridectomy, a small peripheral iridectomy is all that is necessary for safe delivery of the lens.

Simple extraction, without iridectomy, has been disappointing to me because of the frequency of incarceration of a knuckle of iris in the wound after the operation. If this does not occur, the result is ideal, but my experience has led me to abandon it.

THE DOMINANT EYE

ITS CLINICAL SIGNIFICANCE

WALTER H. FINK, M.D.
MINNEAPOLIS

The role which the dominant eye plays in ocular functions is as yet not fully determined. Although it has been recognized as being present, ophthalmologists have been indifferent as to its importance and the part it plays in maintaining normally coordinating eyes. The dominant eye may be defined as that eye which performs the major function of seeing, being assisted by the less dominant fellow eye. To state it differently, the two eyes do not affect the visual consciousness with equal force. One eye leads the other, and this leading eye is called the dominant eye. Just as the two hands are unequal in response, both from a motor and from a sensory standpoint, so are the eyes. Just as a person may be right handed or left handed, so he may be right eyed or left eyed.

Ocular dominance has not been found mentioned earlier than 1593, in Giovanni Battista della Porta's "De refractione." He was apparently the first to refer to the phenomenon. Beginning with the writings of Donders, more frequent references began to appear in the literature. Later reference to ocular dominance was made in the writings of Humphrey in 1861 and in an article by Callan in 1881. Rosenbach and Wray published articles on this subject in the same year (1903), and since 1918 reports of other studies have appeared.

That the human organism is one sided has been long recognized, and many data have been accumulated to support the claims of numerous investigators as to the clinical importance of sidedness. Its significance from the clinical standpoint is therefore well established. The mechanism involved, the importance of maintaining this dominancy and the consequences entailed in disrupting it are fairly definitely known. Such an understanding concerning the importance of ocular dominancy should exist.

Many writers would have one believe that eyedness and handedness are fundamentally the same process, both having a common mechanism and significance. They explain the necessity for eyedness on the same

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basis as manual dominancy; namely, one cerebral hemisphere must dominate the other, because when this dominancy is disrupted incoordination ensues. Can one assume that eyedness and handedness have basically the same physiologic mechanism? It is recognized that the dominant hand is essential in order to carry out highly coordinated actions. Is it of equal importance that one have a dominant eye to carry out the intricate tasks which civilization has imposed on the eyes? One is led to believe from the literature that ocular dominancy is essential for the smooth coordination of the eyes and that when it is not present ocular imbalance and discomforts result. Ophthalmologists are advised to test the ocular muscles with the Maddox rod always before the less dominant eye and to prescribe a prism over this eye; they are told that dominance is a favoring condition for the development of motor skill, fine visual discrimination and high achievement in general.

In considering ocular dominancy, therefore, one is confronted with a problem which may be of academic interest only. But, on the other hand, can it not be of more or less clinical significance? As the matter now stands, one finds little from which to form an opinion and practically no clinical statistics or data with which to substantiate an opinion. A survey of the rather extensive literature reveals that practically all the material on this subject has been contributed by nonmedical investigators, and of the oculists who have contributed, few have substantiated their claims with case reports. It is evident that one who is searching for facts and is skeptical cannot be satisfied with the data available.

It therefore seems justifiable to investigate further the problem of ocular dominancy with the hope of clarifying it to some degree and of assisting in establishing some facts which are based on tabulated data. Two hundred consecutive cases in which refraction was done were analyzed. This number was believed sufficient to obtain data which may be suggestive. Consecutive cases were taken because they would simulate more closely the cases encountered in daily practice. In the course of the investigation it was necessary to discard 75 because they did not lend themselves to the problem. This discarded group was comprised of cases of amblyopia in which the good eye was obviously dominant, in which the cooperation was poor, in which the imbalance was very defective and in which the fusion was extremely poor. To present selected cases in which pronounced deviations were present would not have served the purpose because the answers of the subjects would have been obvious. The 125 cases used for this analysis therefore represent an average group of cases encountered in which the role of ocular dominancy is rather uncertain.

Because of the extensiveness of the subject, the investigation was necessarily confined to a certain phase of it, namely, the practical appli-

cation of ocular dominancy to routine examination of the eyes. The problem was therefore approached from the following angles: (1) the technic for testing ocular dominancy, (2) the nature of ocular dominancy, (3) the influence of ocular dominancy on the ocular mechanism and (4) the influence of ocular dominancy in the management of ocular problems.

TECHNIC FOR TESTING OCULAR DOMINANCY

From a review of the first phase of the subject, it seems evident that there is no perfect test for the determination of the dominant eye. Many have been devised, but critical scrutiny reveals defects in all of them. When dominancy is present to a definite degree, all of the tests give fairly consistent results, but when either eye does not attain a position of definite supremacy and the dominancy of the two is approximately equal, the results of many of the tests are uncertain, and those of only two or three tests show any degree of consistency.

Because of this lack of certainty which exists as to the accuracy of the tests for dominancy, it was considered advisable to investigate first which test is most accurate and adaptable to clinical work. My object was, therefore, to find a test which is simple in technic and yet accurate.

Therefore, in carrying out this problem, the following procedures for determining, and indexes of, the dominant eye were considered: (1) the manoptoscopic method of Parson, (2) Dolman's method for both near and distant vision, (3) a modified alinement method, (4) the position of alinement at close range, (5) the convergence near point method, (6) comparison coordination tests, (7) the winking reflex and the sighting eye, (8) ocular fatigue, (9) facial asymmetry, (10) visual acuity and (11) refraction.

1. The manuscopic method of Parson's was utilized and compared with the method of Dolman. It was soon evident that this test should not be considered as a practical office test. Aside from inaccuracy and uncertainty in answers, the test requires considerable explanation before it is understood by the patient. It also lacks a feature which seems important, i. e., the objective determination of the sighting eye by the examiner.

2. The method of Dolman proved to be satisfactory. Bryngelson's [1] technic of using this method is as follows: A fiber board with a 3 cm. opening is held in both hands. The patient is asked to raise the board and sight through the opening at a small point of light 20 feet (6 meters) away. This is repeated three times with the board held at arms' length, three times with the arms slightly flexed and three times with the arms fully flexed, so as to hold the board within a few inches of the eyes. Between each sighting, the board is lowered and rested on the lap. The

1. Bryngelson, B.: Personal communication to the author.

whole procedure is repeated except that the board is carried from above. The purpose of these repeated trials from above and below is to eliminate the influence of habit as much as possible. The test is repeated, the hole in the board being lined up with a pencil point held at a distance of 2 feet (60 cm.). The purpose of this is to see whether or not there is a uniformity of dominance for distant and near alinement. The Bryngelson method proved to be very practical and lends itself admirably to office routine, as it is easily understood and results are uniformly accurate. The one objection which can be raised is that by using the hands there is a possibility of sidedness entering into the test for distance.

When this method was used in the series of 125 cases, dominance of the right eye was found in 77 cases and of the left eye in 43, while in 7 cases the dominance varied. On the basis of the average dominancy obtained by using all the tests, dominance of the right eye was found in 74 of the 77 cases and dominance of the left eye in 3, while dominance of the left eye was found in 29 of the 43 cases and dominance of the right eye in 14. When the Bryngelson method was used for near vision, dominance of the right eye was found in 73 cases and of the left eye in 43, while ambidexterity was noted in 4 cases. According to the average ocular dominancy, dominance of the left eye was found in 4 of the 73 cases and dominance of the right eye in 15 of the 43 cases.

The results with the Bryngelson modification of the Dolman method, therefore, may be considered highly accurate and fairly consistent with the combined results obtained with the other methods.

3. With the modified alinement method, the examiner holds a pencil 3 feet (90 cm.) from the patient and asks him to line up the pencil with a distant object. In so doing, the patient does not utilize the hands, and the dominant eye is determined by covering one and then the other eye and observing which remains in alinement. The factor of sidedness is eliminated, which is considered by some a serious objection and which is found in the other tests mentioned. However, this test proved difficult to explain to the patient. When this test was used in the series of 125 cases, dominance of the right eye was found in 83 cases and of the left eye in 41, while ambidexterity was noted in 1. A comparison of these results with the average eyedness showed that in 6 of the cases in the first group the left eye was dominant and in 15 of the cases in the second group the right eye was dominant.

Compared with the Bryngelson method, this test did not show any appreciable higher degree of accuracy and was certainly more difficult to carry out.

4. For the test which is based on the position of alinement of objects held at close range, the patient, holding a card, is asked to direct his gaze

at a small number on the card. The observer notes with which eye, if any, the object is in better alinement. The card was alined with the right eye in 33 cases and with the left eye in 22 cases, while in 71 cases it was held in the midline. In a comparison of these figures with the average eyedness, it is noted that in 4 of the cases in the first group the left eye was dominant and in 12 of the cases in the second group the right eye was dominant. This test is but suggestive and not highly accurate.

5. The convergence near point test is performed by asking the patient to fix his eyes on a minute object, which is carried slowly toward him until one eye diverges. The eye which remains fixating is considered the dominant eye. In certain cases in which the divergence was bilateral, it was difficult to determine which eye was dominant. With this test there was deviation of the right eye in 62 cases, of the left eye in 38 cases and of both eyes in 25 cases. The right eye was dominent in 31 of the 38 cases in which the left eye deviated. This test cannot be considered accurate.

6. With the comparison coordination test, the two eyes are compared as to the degree of skill in carrying out coordination acts. The more skilful eye is considered the dominant eye. In the present series of cases two tests were performed, namely, the target and the contact test.

The target test consists of inserting a pencil through a 3 cm. opening in a board placed at arms' length. The patient stands with one eye occluded before the board and holds the pencil in his dominant hand with his arm at his side. He then is asked to raise his arm and attempt to pass the pencil through the hole. This is repeated three times with one eye. This eye is then occluded, and the test is carried out in the same manner with the other eye.

The contact test is performed with an instrument which consists of a board on which is fastened two almost parallel metal strips, 16 inches (40 cm.) long, almost in apposition on one end and slightly more separated on the other end. These are connected to one pole of a battery, and a needle-like piece of metal attached to a wooden handle is connected to the other pole. The patient is instructed to pass the needle between the two metal strips without touching them. The slightest contact between the needle and the bars causes an electric current to be formed, resulting in a buzz. This is repeated three times with each eye, the dominant hand being used and the other eye being occluded.

The target test revealed dominance of the right eye in 93 cases, with right handedness in 90, and dominance of the left eye in 32 cases, with right handedness in 30. The contact test showed dominance of the right eye in 76 cases, dominance of the left eye in 36 cases and ambidexterity in 19 cases. Although these tests indicate dominancy, they are not practical as an office procedure and have the objection that the sidedness may influence the result.

7. The winking reflex proved rather unreliable as a method of determining the dominant eye. It was difficult in many cases to determine which eye was the winking eye. In the series of 125 cases 35 patients winked the right eye, 33 winked the left eye and 57 winked either eye. When these figures were compared with the average eyedness, it was noted that in 12 cases in which the right eye was winked the left eye was dominant, and in 27 cases in which the left eye was winked the right eye was dominant.

Closely related to this test is the determination of the sighting eye. In 93 cases the sighting eye was the right eye, and in 33 cases it was the left eye. According to the general average, the left eye was dominant in 13 of the 93 cases and the right eye was dominant in 15 of the 33 cases.

It is also interesting to note that the right eye was dominant in 10 of 91 patients who used the right eye for shooting.

8. The possibility of ocular fatigue as a factor in the determination of the dominant eye was investigated. In 37 cases the right eye was named as the eye experiencing the greater fatigue on use, and in 7 of these cases the left eye was dominant. In 43 cases the left eye showed fatigue, and in 31 of these cases the right eye was dominant.

9. Facial asymmetry did not seem to be significant in this series.

10. Visual acuity, although not generally considered an important factor in determining the dominancy of the eye, in this series proved to be some indication of dominancy. In 38 cases there was no difference in visual acuity, and in 27 of these the right eye was dominant. In 16 cases there was equal subnormal vision, and in 13 of these the right eye was dominant. In 29 cases one eye was normal and the other was subnormal, and in each case the better eye was dominant.

11. Refraction proved to be of some value in determining the dominant eye. In all instances the eye having the smaller error of refraction showed a high percentage of dominancy. Of 44 cases of myopia, the right eye was dominant in 29. Of 64 cases of hyperopia, the right eye was dominant in 59. Of 89 cases in which there were unequal refractive errors, the right eye was dominant in 66. Of 31 cases of astigmatism over 1 diopter, the right eye was dominant in 21.

In the summary of the methods here used to determine dominancy, results point to the fact that the Bryngelson modification of the Dolman method and the alinement method, which are numbers 2 and 3 as listed, are the most accurate. As a practical method for office use, the Dolman method appears to be more satisfactory because it is more easily understood, quickly performed and inexpensive in construction. The examiner can see the selection and registers in a high percentage of cases. As to the accuracy, it compares favorably with the alinement test, even

though some may object because of the fact that the board is held by the patient.

NATURE OF OCULAR DOMINANCY

The nature of ocular dominance is not by any means understood. Certain phases of it can be fairly well explained, whereas one must theorize in regard to others. Opinions have been expressed as to the various explanations, but much proof is still wanting. It is therefore necessary in order to gain a more correct understanding of the present status of the problem that certain phases of its nature be considered and explanations advanced.

(*a*) Ocular dominancy is a characteristic of the ocular mechanism. In the higher forms of animals, binocular vision is associated with some form of lateral sighting. Among apes, and occasionally in ambidextrous man, this sighting faculty is not fixed but fluctuates laterally according to the position of the visual stimuli on the right or left. With few exceptions, the human race has acquired the faculty of fixed unilateral visual and manual dominance.[2] This probably arose when man made his first attempt to create weapons and tools and required a holding hand and monocular sighting in order to do away with double images, which otherwise would be constant and inevitable with direct and equal binocular vision. One therefore observes that in the examination of two eyes which are exactly alike in manifest and retinoscopic findings that one eye possesses a greater sense of clarity, a greater sharpness for detail and, in general, a greater power and refinement of discrimination. According to Parson and Scheidemann and Robinette,[3] such dominance is absolute because only this master eye sees objects in their true place, while the impressions of the other eye are suppressed by, or lost in, the clearer image of the prevailing eye, save for those parts of the visual field, which, from their position, are seen by the weaker eye alone. These impressions, in turn, are transferred on the dominate eye in such a manner that one imagines that one is seeing through this eye all that one sees only with the weaker eye.

With suitably applied tests, the habit of ocular dominance is found to be almost universally demonstrable in some degree. In this series of 125 cases, all patients showed evidence of ocular dominance when the tests were applied. It is therefore safe to assume that in the great majority of persons there is undoubtedly, aside from normal binocular vision, monocular vision subserving binocular vision and greatly insuring the precision and accuracy of visual projection.

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2. Parson, B. S.: Lefthandedness, New York, The Macmillan Company, 1924, pp. 39-132.

3. Scheidemann, N. V., and Robinette, G. E.: Testing the Ocular Dominance of Infants, Psychol. Clin. **21**:62, 1932. Parson.[2]

(*b*) A relation exists between ocular dominance and sidedness.

According to Parson,[2] bilateral asymmetry of function is limited by no means to the eyes but is so uniformly present in all the paired organs of the body, in the skeletal and muscular structures and functions, in dermal and muscular sense and in all the special senses as to force the recognition that asymmetry of structure and of function is a basic condition of the human body in its present stage of evolution.

As early as 1861, Humphrey [4] discussed the correspondence of function between hand and eye and advanced the theory that eyedness is a cause of handedness. This so-called ocular dominance theory of handedness became the subject of considerable controversy, with the result that most of the studies of eyedness have been incidental to those of handedness. Van Biervliet [5] in 1897 showed that handedness is usually accompanied by a corresponding keenness of the optic, acoustic, tactile, olfactory and gustatory motor nerves on that side of the body. Gould [6] expressed the belief that handedness depends on the better-seeing eye, and the right eye, usually being the better, "compels the right hand to work with it."

Parson [2] concluded that sighting along the right visual line by a right-handed person and along the left visual line by a left-handed person is the direct instrument in the production of sidedness. He reasoned that these visual operations which are carried on monocularly lead inevitably to the preferred use of one hand—the hand nearer the sighting eye—for the greatest anatomic and physiologic advantage. Every consideration of speed, accuracy and economy of muscular effort, and hence the development, safety and well being of the entire organism, demand this intimate correlation of eye and hand on the preferred side.

Miles,[7] in studying left-handed adults and children of school age, and Travis [8] in comparative studies of normal speakers and stutterers, pointed to a possible although not so invariable relation.

In 1936 Kuroda reported the results of a study of Japanese school children in whom he found no significant relation between eyedness and handedness. In a study of over 3,000 males varying in age between 6 and 81 years, Woo and Pearson [9] found a zero correlation between

4. Humphrey, cited by McAndrews, L. F.: Ocular Dominance, Arch. Ophth. **13**:449 (March) 1935.

5. Van Biervliet, J.: L'homme droit et l'homme gauche, Rev. phil., Paris **47**:113, 276 and 371, 1899.

6. Gould, G. M.: Right-Handedness and Left-Handedness, Philadelphia, J. B. Lippincott Co., 1908.

7. Miles, W. R.: Ocular Dominance: Methods and Results, Psychol. Bull. **25**:155, 1928.

8. Travis, L. E.: Speech Pathology, New York, D. Appleton and Company, 1931.

9. Woo, T. L., and Pearson, K.: Dextrality and Sinistrality of Hand and Eye, Biometrika **19**:165 (July 15) 1927.

manual and ocular dextrality. Coons and Mathias, from their study of the tendency toward ocular and manual preference, drew the conservative conclusion that persons with dominance of the left eye tend to be less right handed than those with dominance of the right eye.

However, statistics show that there is a high percentage of correspondence between the dominant side and the dominant eye. It is estimated that pure dextrality (right handedness and right eyedness) occurs in about from 85 to 90 per cent of persons; pure sinistrality (left handedness and left eyedness), in from 5 to 10 per cent, and crossed dominance or absence of dominance (ambidexterity), in from 5 to 10 per cent. Mills [10] concluded that there are two types each of dextrality and sinistrality: 1. Pure dextrality consists of right handedness and right eyedness. This type occurs in about 76 per cent of all persons. 2. Pure sinistrality consists of left handedness and left eyedness. This type occurs in about 9.3 per cent of persons. 3. Crossed dextrality consists of right handedness (usually by training) but left eyedness. This type occurs in about 13 per cent of persons. 4. Crossed sinistrality consists of left handedness with fixation of the right eye and usually divergence of the left eye, though there may be divergence of the right eye. This type occurs in about 1.7 per cent of persons. According to Bryngelson,[1] who examined 400 university students, 25 per cent of right-handed subjects were left eyed, 3.6 per cent were amphiocular and the remainder were right eyed. In the series of cases here reported the findings were as follows: Of the 118 right-handed subjects, 89 were right eyed; the remainder were left eyed, and therefore showed a crossed dominancy. Of the 7 left-handed subjects, 3 showed crossed dominancy.

The following tabulation indicates the sidedness, the ocular dominancy and the percentage of ocular dominancy in the group analyzed:

Right Eye Dominant, Percentage of Dominancy	Right Sidedness, No. of Cases	Left Sidedness, No. of Cases
100	64	1
90	14	1
80	5	0
70	5	0
60	1	1
50	0	0
Left Eye Dominant, Percentage of Dominancy		
100	19	1
90	7	0
80	1	1
70	1	0
60	1	1
50	0	0

10. Mills, L.: Unilateral Sighting, California & West. Med. **28**:189 (Feb.) 1928.

That these explanations of eyedness cannot be accepted without question is evident, although one is impressed with the fact that many features of eyedness suggest some points which justify some such explanation. It must be kept in mind that in certain respects the ocular functions differ from the functions of the hand. The functioning of the two motor coordinations (hand and eye) are really not analogous. For example, picking up a needle requires the use of but one hand; to use both hands for such a task would be clumsy. The needle is, however, viewed with both eyes as one reaches for it and is threaded on the basis of binocular impressions. Again, throwing is done with one hand, but both eyes remain open. It is typical, then, to use one hand or the other and habitually one, but in vision one characteristically uses both eyes, and under some special circumstance or as an aid to some particular motor skill, only one eye.

It seems logical, therefore, to conclude that more than 75 per cent of all human beings are right eyed and 23 per cent are left eyed, and in about 2 per cent ocular dominance is indifferent or is distributed between the two eyes. Practically all right-eyed persons are right sided. In the case of left-eyed persons this relation is not as constant. Many of them are right handed through training. Parson [2] expressed the belief that tests for ocular dominancy show the original rather than the existing conditions of handedness and that teachers, nurses, parents and associates have all conspired to turn sinistrality into dextrality. He reasons that as virtually all the right-eyed persons are at the same time right handed, one is justified in believing that the natively left-eyed persons, irrespective of their present manual preference, were all originally left handed. Cuff [11] has arrived at similar conclusions. In his report it is stated that from 20 to 30 per cent of the children were probably left handed natively; also that 100 per cent of the right-eyed children were found to be right handed. Various authors place the incidence of native left handedness at from 4 to 27 per cent. Undoubtedly a high percentage of natively left-handed persons have shifted to the use of the right hand.

It therefore seems evident from the information available that eyedness and handedness are to some extent related. Whether the relation is of such a degree that the one influences the other cannot be definitely stated. To accept Parson's theory that eyedness is the fundamental factor and handedness is dependent on it would greatly simplify the problem. There is no question that Parson took the subject out of the realm of speculation to a certain degree by his demonstration of the optical necessity for unilateral sighting.

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11. Cuff, N. B.: Relation of Eyedness and Handedness to Psychopathic Tendencies, J. Gen. Psychol. **37**:532, 1930.

(*c*) Ocular dominancy is stable.

While training, accident or disease may reverse the manuality of a person, eyedness, i. e., the exclusive use of either the right or the left visual line for sighting, persists tenaciously throughout life, severe ocular disease early in life or practical blindness in adults being necessary to cause its reversal. The conditions which would be supposed to modify ocular mastery usually produce the expected modification. Ulcers or injuries of the cornea in early childhood which have left severe scarring and disease or injury of the lens, retina, macula or choroid occurring congenitally or early in life are likely to throw the mastery to the unaffected or to the less affected eye if there is much loss of vision. Again, when a high degree of astigmatism exists in one eye, it is almost certain to be present in the eye which lacks dominance and nearly always is related to the side of the body which has the poorer function. Exceptions to this general rule are not rare in cases of myopia, in which at times the sighting eye yields first and to a greater degree than the other eye. On the basis of observations made on several thousand persons, Mills [10] stated that when the special paths of binocular control and monocular mastery once are established they are not likely to be modified after adolescence by any disease or injury which still permits vision of approximately 6/20 in the affected eye. Parson stated that once dominancy is acquired it is never changed by education or training. Only when the dominant eye has suffered an injury or visual depreciation can the transfer be effected. In adult life special habits or special training involving the use of one eye especially, such as prolonged uniocular microscopic observations, does not determine ocular dominance and does not alter a preference already established.

Therefore, all the evidence points to the fact that once a preference is established it can be reversed only with difficulty.

(*d*) Ocular dominance promotes mental stability and better coordination.

Work by Cuff [11] suggested that those persons who have a strong unilateral sighting tendency are the ones who are most nearly normal emotionally. His data suggest that these persons are likely to have fewer psychopathic traits. Mills [10] called attention to the nervous instability of children in whom there is crossed dominancy. Oates [12] found the highest percentage of speech defects in persons with crossed sinistrality, i. e., those who are right eyed and left handed. Dearborn also found numerous cases of reading disability allied with mixed dominance. According to Chandler, more psychotic than normal persons prefer a noncorresponding eye with a corresponding hand and foot.

12. Oates, D.: Ocular Dominance, J. Gen. Psychol. **39**:492 and 423, 1931.

Another interesting fact in connection with crossed dominancy is its influence on general coordinated actions. Freeman and Chapman,[13] experimenting with coordination of the hand and eye, concluded that skill can be acquired only to a certain degree by those who are not well coordinated as compared with those who have better coordination. According to Mills,[10] persons with right manuality often are discovered to be left eyed by their indifferent or uncertain ability at golf, shooting, tennis, baseball and other types of sport. He expressed the belief that in these games, played with both eyes open, a person with crossed dextrality or crossed sinistrality is at an anatomic and physiologic disadvantage as compared with a person with pure dextrality or pure sinistrality, whose sighting line and preferred hand are on the same side and work together naturally. The intimate grouping of the principal motor centers is disarranged in the person with crossed dominancy, and in the transfer of part of the activities to the other cerebral hemisphere a certain amount of indecision and awkwardness often is apparent. So long as a person with crossed dextrality does not strain and merely uses muscle sense and two-eyed vision, he shoots and plays games reasonably well, and at times very well, but when he becomes particularly anxious, by the very nature of ocular dominance he must pick up his alinement with the left eye and miss widely to the left. In other words, when exact sighting is necessary, binocular vision is replaced by monocular vision and the sight is brought into line with the object by the master eye along its line of vision. Obarrig,[14] however, expressed the belief that the question of sight is of relatively secondary importance throughout the whole realm of sports and that the matter of muscle coordination, quick perception, adaptability, responsiveness, reaction to surroundings, and temperamental nature, plus other items, with or without regard to eyedness and handedness, constitute a proficient player.

Investigation of this series of cases to determine which combination of handedness and eyedness was the most coordinated showed that the coordination was the best with the target test when the dominant eye and the dominant hand were used. In an analysis of the contact test for the degree of coordination, a similar result was obtained.

The foregoing results are but suggestive. Undoubtedly it is of some advantage and promotes better coordination to have the dominant eye and the dominant hand on the same side.

(*e*) Ocular dominance is independent of visual acuity and refraction.

The relation of visual acuity to ocular dominancy is of value in analyzing the nature of dominancy. It has been found that occasionally

13. Freeman, G. L., and Chapman, J. S.: Relative Importance of Eye and Hand Dominance in a Pursuit Skill, Am. J. Psychol. **47**:146, 1935.

14. Obarrig, P., in discussion on Mills, L.: Eyedness and Handedness, Am. J. Ophth. **8**:933, 1925.

the eye with the lower visual acuity is the dominant eye. According to Bryngelson,[1] ocular dominancy is not related to visual acuity or refraction, although these may be determining factors. Gahagan [15] studied the ocular dominance and visual acuity of 100 persons to discover whether or not a relation exists between these two visual conditions. He concluded that superior visual acuity of a given eye is not indicative of a corresponding dominance of that eye.

The relation of visual acuity to dominancy, as noted in the series of cases here reported, is as follows: The right eye was dominant in 27 of 38 cases in which the vision was normal and equal in both eyes; it was also dominant in 13 of 16 cases, in which vision was equal but below normal. The better eye was dominant in 21 of 29 cases in which the vision was normal in one eye and subnormal in the other. The dominant eye was the better eye in 30 of 40 cases in which the vision was below normal in one eye or in which it was less defective in one eye than in the other.

(*f*) Ocular dominancy is established early in life.

The age at which ocular dominancy develops is a factor in analyzing the nature of dominancy. Little or no evidence is available as to when the preference for one eye first develops or whether the habit is established as a result of environmental conditions or tendencies of motor coordination. According to Schneidemann,[16] impartial eyedness is more common in young children. From a comparison Schneidemann's results with those of others studying older children, indications are that impartial eyedness is more common in preschool children than in children of school age. There was no apparent difference in the incidence of eyedness on the basis of sex. It seems justifiable to believe that ocular dominance is not established in many children before the age of 3; thereafter it is commonly found.

(*g*) Anatomic evidence of the nature of ocular dominancy is not conclusive.

McAndrews [17] stated that Linebrook examined automatically 18 pairs of human eyes in an attempt to discover whether there was any structural condition in the right eye to account for ocular dominance. In every pair of eyes examined the fovea was found closer to the optic disk in the right eye than in the left. He expressed the belief that this may explain the dominancy of this eye, basing his belief on the assump-

15. Gahagan, H. L.: Visual Dominance: Acuity Relationships, J. Gen. Psychol. **8-9**:455, 1933.

16. Schneidemann, cited by Schoen, Z. J., and Scofield, C. F.: A Study of the Relative Neuromuscular Efficiency of the Dominant and Non-Dominant Eye in Binocular Vision, J. Gen. Psychol. **12**:156, 1935.

17. McAndrews, L. F.: Ocular Dominance, Arch. Ophth. **13**:449 (March) 1935.

tion that the fovea of the right eye reaches the line of vision more quickly than that of the left.

(*h*) Ocular dominancy does not shift when the focus is changed from distant to near vision.

In practically all the cases analyzed the same eye was dominant for both distant and near vision. For example, when ocular dominancy for distant vision was tested, the right eye was dominant in 77 cases. In repeating the test for near vision, the right eye was dominant in 73 cases. In other words, no appreciable difference exists in ocular dominance for distance and near vision.

(*i*) Facial asymmetry is not a factor in ocular dominancy.

In the present series of cases there was no relation between facial asymmetry and ocular dominancy. All patients showed an average degree of facial asymmetry, and even those who showed a somewhat greater degree of facial asymmetry did not show a greater degree of ocular dominancy.

(*j*) In cases of stabismus the turned eye is usually the less dominant eye.

In 6 cases in this series a history of strabismus was obtained. In all of these the deviating eye was the nondominant eye.

The symptom of ocular fatigue is of little significance in ocular dominancy.

(*k*) The symptom of ocular fatigue was used as a possible index as to whether the dominant eye, being supposedly used more, would show evidence of fatigue before the nondominant eye. Analyzing this series of cases showed that the right eye was designated in 44 cases, in 31 of which this eye was dominant.

(*l*) The duration of wearing glasses has no influence on the degree of dominancy.

This phase was investigated in the series of cases reported here. For example, of those persons who had worn glasses for less than one year, the group with the right eye dominant showed a dominancy of 74 per cent, and the group with the left eye dominant, a dominancy of 69 per cent; of those who had worn glasses for ten years or more, the group with the right eye dominant showed a dominancy of 74 per cent, and the group with the left eye dominant, a dominancy of 75 per cent.

(*m*) The degree of dominancy does not vary appreciably in persons using their eyes to a slight degree for fine work as compared with those who use their eyes excessively.

This was found to be true in the present series of cases.

(*n*) Sex is not a factor in dominancy.

When dominancy was analyzed from the standpoint of sex the right eye was dominant in 43 of the 53 male subjects and in 51 of the 73 female subjects.

In summary, it is evident that when considering the nature of ocular dominancy one is dealing with a subject which is imperfectly understood, not only as to the basic nature but as to its application to clinical problems. Whether it is a physiologic or a psychologic process is unknown, although there are some data to support both sides. One must, therefore, theorize as to its nature. There are certain characteristics of its nature which are suggestive. Ocular dominancy seems to be a characteristic of the ocular mechanism, as it is uniformly present to some degree in practically all cases. There seems to be a relation between ocular dominancy and sidedness. Whether one depends on the other is not known, but the explanation of Parson makes the mechanism easily understandable and in some respects logical when considered in the light of recent views put forth on sidedness. One is therefore tempted to theorize as does the pathologist who explains speech defects on the basis of a disruption of a perfect balance in the coordination of the two hemispheres. The perfect coordination which must exist in the eyes may be comparable to that of handedness and can be maintained only by the presence of a dominant eye.

Another characteristic of dominancy is its stability, and like handedness it cannot actually be shifted unless the vision is greatly lessened in the dominant eye. Dominancy is established apparently early in life and becomes more evident with age. Ocular dominancy seems therefore to be a centrally located process rather than a peripheral one, as it is evidently not related to vision, refraction, habits and other such factors.

INFLUENCE OF OCULAR DOMINANCY ON THE OCULAR MECHANISM

Although many phases of the phenomenon of binocular vision have been investigated, relatively little is known of the fundamental mechanics of the process. Such processes as the fusion of dissimilar images and binocular rivalry are but imperfectly understood. The fact of ocular dominance has long been known, but little studied, except with respect to its incidence and its relation to handedness. Its significance in the actual mechanism of binocular vision has received scant attention. The simultaneous functioning of the two eyes is a process certain to be materially affected by the fact that one eye is functionally dominant, and in this binocular act it is highly probable that the behavior of the nondominant eye differs essentially from that of the dominant eye.

In discussing the influence of the dominant eye on the ocular mechanism, I shall assume that ocular dominancy does exist. This being the case, what benefit does the ocular mechanism derive from its presence? Time does not permit the consideration of all angles of this question; so only certain phases will be discussed.

(*a*) Does ocular dominancy act as a stabilizer on the ocular mechanism and tend to promote binocular coordination or unity of action between the eyes?

The degree of binocular coordination or unity of action between the eyes may depend on the following factors: (1) the degree of binocular fusion or stereoscopic vision (2) the ocular muscle balance, (3) the adduction power, (4) the near point of convergence and (5) the presence of paresis of the ocular muscles. Knowing these factors, one is in a position to form some opinion as to the degree of binocular coordination.

Therefore, in attempting to answer the foregoing question these factors were investigated in the present series of cases, and the average of the results of the various tests were considered as the degree of binocular coordination. This, in a measure, gives some basis for comparison of the individual case.

1. In estimating the degree of fusion, or depth perception, three methods were employed: the red glass test, as described by Duane; the degree of stereopsis, and the degree of depth discrimination, as determined by the apparatus of Howard and Dolman. Although other tests may be used for this determination, it was believed that by using the aforementioned tests the results would be sufficiently accurate so that the data would be fairly suggestive and a comparatively accurate idea could be obtained as to the degree of fusion and stereoscopic vision.

The red glass test as described by Duane consists of placing a red glass before the right eye and asking the patient to direct his gaze to a muscle light 20 feet away. If he is able to superimpose the red and the white light, it is assumed that the fusion power is not weakened. If the two lights are not superimposed, even after a few moments' delay, it is assumed that the fusion power is poor. If the superimposing of the two lights is delayed, it is assumed that the fusion power is weakened. In this series of cases 90 of the patients were able to superimpose the two lights; 68 of these were right eyed. Of the remaining 35 who were unable to superimpose the two lights, 20 were right eyed.

The determination of the degree of stereopsis consisted of using the usual stereoscopic tests, as suggested by Worth. All of the patients on whom this test was used showed third degree fusion.

The degree of depth discrimination was determined by the test of Howard and Dolman. According to the accepted technic, 2.5 cm. of separation is considered a normal degree. Of the 119 patients showing less than 2.5 cm. of discrimination, 93 were right eyed and showed 74 per cent of dominancy. Of the 6 who showed more than 2.5 cm. of discrimination, 5 were right eyed and showed 78 per cent of dominancy.

2. The ocular muscle balance also was used as a criterion as to binocular coordination and unity of action between the eyes. The balance was taken with the Maddox rod over the dominant eye and again with the rod over the less dominant eye. In the group of cases analyzed, it was found that a definite correlation existed between the degree of ocular dominancy and the muscular balance. A higher degree of coordination of the eyes was found when the balance was within normal limits.

3. Duction power of the muscles was utilized as an indication of the degree of binocular coordination. The procedure was as follows: The adduction power was obtained by placing the rotary prism before the dominant eye, and the duction power of the horizontal muscles was measured. The rotary prism was then placed before the less dominant eye and the procedure repeated. The result tabulated was the average of three trials. The fixing object was a muscle light at a distance of 20 feet. A correlation of these findings with the degree of ocular dominancy revealed that when the abduction power was 8 degrees or over the patients showed at least 75 per cent of ocular dominancy. Likewise this was true when 10 degrees of adduction or over was considered the minimum degree of adduction.

In the tests for both adduction and abduction power, changing the prism from one eye to the other did not materially alter the results.

4. The near point of convergence was also determined in the present series of cases, and in 46 it was found to be more remote than is usually considered normal. Any figure over 100 mm. was considered remote. Dominancy had the following relation to the near point of convergence: There were 10 cases in which the near point of convergence was 70 mm.; in 8 of these the right eye was dominant, and in all there was a high degree of dominancy. There were 69 cases in which the near point of convergence was under 100 mm.; in 53 of these the right eye was dominant, and the degree of dominancy was over 75 per cent. In the cases in which the near point of convergence was under 100 mm., the average percentage of binocular coordination was 66, a much lower figure than would be expected. There were 46 cases in which the near point of convergence was over 100 mm., and in 35 of these the right eye was dominant, and there was less than 75 per cent of dominancy.

5. In a consideration of the binocular coordination and unity of action between the eyes, it is important to bear in mind the possibility of paresis of the ocular muscles. The cover test was thought to be the best method of approaching this question, but it was discarded in favor of the diplopia field test, which more graphically shows the conditions of the muscles. In the group of cases analyzed, no diplopia was noted in 43 cases, in 32 of which the right eye was dominant. Diplopia

in two fields or more was noted in 50 cases, in 37 of which the right eye was dominant. The ocular coordination in the first group was 92 per cent, and in the second group, 75 per cent.

The relation between ocular dominancy and binocular coordination in this group of cases is summarized as follows: In 93 cases in which the right eye was dominant and there was an average of 75 per cent of dominancy, there was binocular coordination of 91 per cent. This same relation held for the 31 cases in which the left eye was dominant, the percentage being practically the same. It therefore suggests that when dominancy is definite binocular coordination is better than average.

(*b*) Does ocular dominancy promote better unity of action between visual activity and other body activities?

According to Parson, Mills and others, it is believed that sidedness is originally determined by eyedness and that for the efficient performance of many acts in which vision and the hand enter the dominant eye is an important factor in carrying out the action efficiently.

A series of tests were performed in which the degree of coordination of the two eyes and the two hands was employed in various combinations. Two tests which called for a high degree of coordination were utilized, namely, the target test and the contact test. The tests have been previously described. In each test the following combinations were used: the dominant eye and the dominant hand; the dominant eye and the less dominant hand: the less dominant eye and the dominant hand, and, lastly, the less dominant eye and less dominant hand.

The results with the target test were as follows: In 81 cases the use of the dominant eye and the dominant hand resulted in the highest degree of coordination. The combination with the next highest coordination was the dominant hand and the less dominant eye.

The results for the contact test were as follows: In the greatest number of cases the use of the dominant eye and the dominant hand resulted in the highest degree of coordination. The next highest degree was shown by the dominant hand and the less dominant eye.

Lund [18] reported a study of the relation of ocular dominancy to coordination of the eyes and hands. Four groups of subjects representing the four combinations of ocular and manual dominancy were subjected to the common target striking test under three ocular conditions—binocular vision, monocular vision with the dominant eye and monocular vision with the nondominant eye. The best scores were made when both eyes were used; the poorest, when the nondominant eye was used.

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18. Lund, F. H.: Dependence of Eye-Hand Coordinations upon Eye-Dominance, Am. J. Psychol. **44**:756, 1932.

Freeman and Chapman [13] concluded that there can be no doubt about the fact of dominance. It is apparent from these tests of efficiency in actual eye-hand adjustments. But it must be equally apparent (1) that one has binocular as well as monocular vision and (2) that high test efficiency is achieved when the two forms of vision are permitted to cooperate. It does seem evident that the dominant eye in cooperation with the dominant hand results in better coordination.

(*c*) Is binocular coordination greater when the dominancy is more pronounced?

It was found that in 35 cases in which there was 100 per cent coordination the degree of dominancy averaged 76 per cent and the right eye was dominant, and in 9 cases in which there was 100 per cent coordination the degree of dominancy averaged 65 per cent and the left eye was dominant. In 11 cases in which there was 78 per cent of coordination the degree of dominancy was 65 per cent. This suggests that a high degree of binocular coordination is associated with a high degree of ocular dominancy.

(*d*) Is this binocular unity greater when the dominant eye is not suppressed?

To lessen the visual acuity of the dominant eye by improper glasses and thereby give the less dominant eye better vision may tend to weaken the binocular unity and cause symptoms, as suggested by the following case: Mrs. B., aged 45, suffered from symptoms of ocular fatigue. Examination revealed that she was presbyopic. Equal additions were given to her distance correction, which unknowingly caused the less dominant eye to see clearly, whereas, vision with the dominant eye was distinctly blurred. She was very uncomfortable until a greater addition was made to the reading correction for the dominant eye, which not only produced better vision in this eye but balanced the near points.

(*e*) Does ocular dominance influence convergence?

In looking at an object at close range does the nondominant eye do most of the converging, the dominant eye remaining fixed or converging very little? In nearly all textbooks binocular vision is represented and discussed on the basis of triangulation. The line joining the nodal points of the eyes is considered the base of this triangle, and the object fixed by both eyes in the median plane is considered equidistant from the two nodal points. Binocular single vision is thus graphically diagramed and discussed as though each of the two eyes was equally dominating and directing. As a result, the most accurate fixation, from the standpoints of ease, comfort and proper location in space of any object, would occur if the object fixed was located on the median line perpendicular to the ocular base line. Thus equal amounts of accommodation and equal

amounts of actual turning in, or convergence, of each eye would result. In most cases, according to Sheard,[19] no such ideally simple arrangement exists, and equal division of labor probably is not present. In cases of dominance of the right eye, simple tests show that ordinarily the object fixed is definitely located and sighted by the right eye. The visual triangle, so far as binocular single vision is concerned, is a right-angled triangle with the right angle subtended at the nodal point of the right eye. The angle merely is reversed in left eyedness.

Schoen and Scofield [20] expressed the same views.

In other words, in cases in which a dominant, or directing, eye exists, the dominant eye is the eye which sights or fixates the object and, all other things being equal, involuntarily acts through the function of accommodation to the end that the object is seen as distinctly as possible. The nonfixating, or nonsighting, eye, on the other hand, is not primarily involved in sighting or in the initial endeavor to see distinctly, but is the moving eye, and as such it converges to give binocular single vision and hence fulfils its function of estimation of distance and actual location of the object in space.

In the present series of cases a shifting from the midline was found in 100 cases. In 62 cases the shift was to the right, and in 38, to the left. In the first group, the right eye was dominant in 44 cases, and in the second group the left eye was dominant in only 7 cases. According to these figures the direction of shifting does not determine the dominant eye. The degree of dominancy did not seem to be a factor.

It is therefore evident that in certain cases the alinement is before one or the other eye, which means that one eye does more converging. Although one would expect the nondominant eye to do more of the converging as the object is shifted to the dominant side, this was not always so in the cases here analyzed.

In conclusion, it seems evident that ocular dominancy exerts some influence on the ocular mechanism. There is some evidence that ocular dominancy acts as a stabilizer on the ocular mechanism, because it is suggestive that the greater the dominancy the greater the ocular coordination. Some evidence points to the fact that ocular dominancy must be maintained as is, because suppressing it may cause ocular incoordination. The influence of dominancy on convergence is a factor to be considered. That certain persons aline an object before one eye more than the other was found in this series of cases, but the object was not always alined before the dominant eye.

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19. Sheard, C.: Unilateral Sighting and Ocular Dominance, Am. J. Physiol. Optics **4**:567, 1923.

20. Schoen, Z. J., and Scofield, C. F.: A Study of the Relative Neuromuscular Efficiency of the Dominant and Non-Dominant Eye in Binocular Vision, J. Gen. Psychol. **12**:156, 1935.

THE INFLUENCE OF OCULAR DOMINANCY IN THE MANAGEMENT OF OCULAR PROBLEMS

The dominant eye, according to certain observers, is of clinical importance. Sheard, Pascal, Mills and others expressed the belief that the matter of finding the dominant eye is not merely a subject of academic interest but one of distinct practical value. They point out the importance of its influence in measuring and correcting heterophoria, its significance in correcting refractive errors, and its importance in myopia and in operations on the ocular muscles.

Because there is little in the literature to refute the various claims of this group, one must reserve an opinion. However, it is suggestive that the lack of interest in the subject on the part of ophthalmologists suggests in itself that it is of little clinical importance.

In the analysis of the cases herein presented an attempt has been made to determine in a measure the value of ocular dominancy in clinical examinations and treatment. Undoubtedly certain phases of routine investigations of the muscles are incomplete. This fact is evident because every ophthalmologist comes in contact with certain cases in which he is at a loss how to proceed, not only in the analysis but in the management. If ocular dominancy is a factor which has not been given sufficient consideration, it should be welcomed and included in clinical examinations. If it is but an interesting fact, it should be treated as such.

Therefore, to shed more light on the subject, the following questions and factors are considered:

1. In performing tests for ocular muscle imbalance, does ocular dominancy influence the procedure?

For examinations in cases of various types of phoria it has been advocated by some that the Maddox rod be placed before the less dominant eye and the imbalance determined by the use of prisms before this eye.

According to Maddox and others, each of the eyes is free to fix either the spot of light or the Maddox rod, whereas Mills [10] expressed the belief that the distorting or dissociating device should be placed before the nonfixating, or the nondominant, eye, when such a condition of dominancy exists. By such a procedure the directing eye looks at the natural test object and definitely fixes it, while its mate, naturally accustomed to moving in coordination with the directing eye, will readily disclose its latency of error in this function of convergence coordination. If, on the other hand, the dissociating device is placed before the dominant eye and the naturally nondirecting eye is allowed to attempt fixation of the test object, a conflict of functions is immediately set up and an uncertain, vacillating state of affairs is present.

Sheard [19] compared the amount of heterophoria manifested when the Maddox rod was placed over the dominant eye with that manifested when it was placed over the nondominant eye. He found that when the dominant eye was fixating (the Maddox rod over the nondominant eye) the degree of heterophoria was greater in 66 per cent of the cases and less in 7 per cent than when the rod was placed over the nondominant eye. It was the same in 17 per cent of cases. The degree of heterophoria was less when the fixation function of the dominant eye was destroyed by placing the Maddox rod before it. Even under such conditions it seems probable that a tendency exists for the dominant eye to regain its fixation capacity. Since under the conditions of the test the nondominant eye is also fixating, there is an inclination toward fusion of the two dissimilar images, the distance between them becoming less.

Although the foregoing statements seem logical, further substantiation is indicated. In this investigation the patients were examined as follows: the muscle balance of each patient was tested with the Maddox rod before the nondominant eye, and the amount of imbalance was measured by placing the rotary prism before this eye. Measurements were again taken with the rod and prism before the dominant eye. A comparison of the result is as follows: With the Maddox rod at 6 meters, it was found that changing it from the dominant to the less dominant eye produced a difference of less than 2 degrees in the readings, in 83 cases, whereas in 2 cases a difference of over 2 degrees was noted. The amount of imbalance was not always greater than 2 degrees with the rod before the less dominant eye. The right eye was dominant in 63 of the 83 in which a difference of less than 2 degrees was found, whereas it was dominant and there was a lower percentage of binocular unity in 32 of the 42 cases in which there was a greater degree of difference. With the Maddox rod at 33 cm., a difference of less than 2 degrees was found in 91 cases and of more than 2 degrees in 34 cases. The right eye was dominant in 70 of the 91 cases, whereas it was dominant in 26 of the 34 cases. In these cases likewise there was not always an increase in the imbalance when the rod was shifted from the dominant to the less dominant eye.

These results suggest that changing the Maddox rod from one eye to the other can produce an appreciable difference in the readings in about one third of cases, with a greater difference for distant than for near vision. Whether the right or the left eye is dominant does not seem to be a factor. The difference was greater in the eyes with poor coordination.

2. In testing the duction power of the eye, does ocular dominancy influence the procedure? Should duction be tested with the rotary prism

before the nondominant eye only, or will the results be the same if it is placed before either eye?

Schoen and Scofield,[20] from their work on relative neuromuscular efficiency of the dominant and the nondominant eye, concluded that the threshold for diplopia—the extent to which the eye may overcome prismatic stress before binocular single vision is disrupted—is greater for the nondominant than for the dominant eye. They found that the difference is small, barely larger than the unit used, but that it is consistent. The duration of postduction diplopia—the time required for each eye to establish single binocular vision after its disruption by the removal of a surmounted prism—is significantly less for the nondominant than for the dominant eye. They expressed the belief that it is conceivable that prismatic interference of the habitually fixating, or dominant, eye produces a lower efficiency of the whole binocular mechanism than when the nondominant eye is subjected to such interference. Hence, a greater neuromuscular efficiency of the nondominant eye is manifested. If, as observation suggests, the readjusting movement of the nondominant eye follows the fixating act of the dominant eye, the practice of the latter in habitually doing this may account for the difference in the speed of readjustment.

According to the analysis of the cases here reported, the following facts were noted: When adduction was measured, a difference of 2 degrees or more was found in 34 cases when the prism was shifted from the dominant to the nondominant eye, the amount of imbalance being in most cases greater than 2 degrees. This difference was found in 25 cases when the prism was over the left eye, and in 9 when the prism was over the right eye. The right eye was dominant in 20 of the group of 25 cases, whereas it was dominant in 8 of the group of 9 cases.

In an analysis of the abduction, a difference of 2 degrees or more was found in 12 cases when the prism was shifted from the dominant to the nondominant eye. The amount of imbalance was not always greater. This difference was found in 7 cases when the prism was over the left eye, and in 4 of these the right eye was dominant; in the remaining 5 cases the difference was noted when the prism was over the right eye, and in all of these the right eye was dominant.

These results suggest that the reading obtained with the rotary prism before one eye may differ from that obtained when it is placed before the other eye. Although the difference is noted in a small percentage of cases, it is present and must be considered.

3. What is the relationship between the degree of dominancy and the coordination or binocular unity of the eyes?

In this series of cases in which the degree of binocular coordination was high, the degree of dominancy was also high.

4. Does the dominancy of the eye have any influence on the placing of prismatic corrections before the eyes?

In the matter of prismatic corrections, Mills [10] stated that prisms are most comfortably worn when placed over the subordinate eye. When a high power prism is necessary and is too strong to be placed over one eye, one third of the correction may be placed over the dominant eye and two thirds over the subordinate eye. Sheard [19] advised that if prismatic corrections are incorporated in glasses, prisms should not be incorporated in the lens worn before the dominant, or the sighting, eye. In cases of squint in which one tries to restore binocular single vision, prisms are to be prescribed; it seems logical, according to Sheard, that they should be placed before the squinting eye.

There may be some grounds for believing that these statements are worthy of further consideration. Practical experience, however, indicates that the equal division of prismatic corrections is a procedure which has stood the test of time. Although no experimental evidence is herein tabulated, daily experience justifies this statement. It does not seem logical that an equal amount of the prism before each eye should interfere with the relation between the two eyes, at least not to the extent as would a dissociating factor like the Maddox rod. Certainly the appearance and proper balance of the weight of the glass are factors arguing for an equal division of the prism.

5. What relation does ocular dominancy have to refraction?

Mills stated that it is important to note that in cases of myopia the fixating eye usually is more myopic, and myopia appears earlier in this eye. In an analysis of 32 cases of myopia, the following fact was determined: In 19 cases it was found that the dominant eye corresponded to the eye with the greater amount of myopia, whereas in the remainder the dominant eye was the one with the least myopia.

It has been noted that in cases in which the dominant eye is the poorer of the two eyes visually the patient is more prone to ocular discomfort when the eyes are under stress.

6. What is the effect of suppressing the dominant eye by overcorrection?

Mills expressed the belief that there is great visual and nervous advantage in maintaining the existing dominance when correcting refractive errors. "Giving a mastery to the non-dominant eye," he stated, "is likely to cause anguish both to the patient and to the physician." Sheard [19] reiterated Mills' warning, declaring that if anything is done to leave the visual acuity of the dominant eye lower than that of the nondominant eye, discomfort will ensue and persist. Does one create a similar situation when in the process of developing an amblyopic eye the better seeing eye is occluded? It has been noted that in carrying out this procedure some patients' reaction suggests more of an upset

than others. For example, an 8 year old child with vision of 20/20 in his left eye had this eye completely and constantly occluded. Evidence of incoordination in his speech developed, and he was in a highly nervous state. Is it possible that, as in shifting handedness, a fine coordinated balance in the higher centers is disturbed? In a stable person such a change has no appreciable effect, whereas in an unstable person the change disrupts the whole nervous mechanism.

It therefore seems logical, with the present meager knowledge of the significance of dominancy, that in correcting errors of refraction one should maintain the mastery or better visual acuity in the dominant eye.

7. Another point which may be of practical value is the consideration of the normal line of vision.

In holding reading matter before the eyes it has been found that certain persons line it up with the dominant eye. To illustrate, a 46 year old patient required bifocal lenses. He was uncomfortable when wearing them and complained that he could not see well with his left (less dominant) eye. Examination revealed that he was holding his reading matter directly in front of his right (dominant) eye and that he was looking with his left eye through the edge of the left bifocal segment. As soon as this fact was called to his attention and the reading matter shifted to the midline, he was comfortable.

In the group of cases here reported this tendency toward deviation was present in 96 cases. In 59 of these the deviation was to the right, and in 58 of these the right eye was dominant. In this group the percentage of dominancy was 75 and of binocular coordination, 92. In 37 cases deviation was to the left; in 15 of these the right eye was dominant, and the percentage of dominancy was 65 and of coordination, 91. In 22 of the cases in this group the left eye was dominant, and the percentage of dominancy was 67 and of coordination, 90. There were 29 cases in which there was no deviation; in 24 the right eye was dominant, and the percentage of dominancy was 77 and of coordination, 90. The foregoing figures indicate that dominancy and coordination do not seem to be the factor in determining whether an object is held before one eye more than the other. The figures do suggest that in a greater percentage of cases deviation is in the direction of the dominant eye.

It therefore seems necessary to check the position of reading matter in relation to the eyes. Undoubtedly in cases of mild deviation it is not significant, but in cases of marked deviation, as illustrated, it assumes importance.

8. In relation to operative work on ocular muscles, the dominant eye, according to O'Connor, plays a part.

O'Connor's technic for bringing the eyes into a parallel position involves the nonfixating eye. Although this phase of surgical work on the ocular muscles is not generally emphasized, one should be aware of it. Undoubtedly most ophthalmologists in selecting the eye for an operation on the muscles select the less dominant eye when but one is to be operated on, because it shows the squint more consistently and usually is the poorer eye visually. That all such operations should be confined to the nondominant eye seems illogical.

The question of selecting the less dominant eye for operation naturally leads to the application of this principle to operations for cataract. In cases in which both eyes are cataractous and the findings much the same, it suggests that one should operate on the dominant eye first. This dominancy could be determined by the handedness of the patient and by questioning him as to his ocular habits if a sighting test is not possible. This suggests the possibility that if but one eye is to be operated on it is possible that the patient will adjust himself to the new condition if his dominant eye is the seeing eye. This seems especially so if the right eye is dominant and the subject is right handed, because some believe the right eye directs the actions of the right hand more efficiently than the left eye.

9. The final consideration of this phase of the subject is the possibility of utilizing the test for dominancy as a test for malingering. It is recognized that only a marked loss of vision will cause a shift of dominancy. The real dominancy can be inferred frequently from the history and the sidedness. In using the Bryngelson test for dominancy, the examiner can see exactly which eye is dominant. If the defective eye happens to be the dominant eye, a certain amount of information as to the vision can be obtained without the patient's knowledge. If it is very defective, as he may claim, the dominancy will be shifted to the other eye.

In summary, it seems evident that in considering this phase of the work one is in an interesting field but also a field in which actual facts concerning dominancy are few. One must therefore accept its various angles in this light, because it would be impossible to be dogmatic. The most logical part of this phase of the work is the matter of the dissociating element. Although data are not conclusive, they do suggest that there is a difference in the amount of the hyperphoria when measured before one eye and then the other. There certainly can be no serious objection, and perhaps some logic in the light of the known facts, to placing the Maddox rod before the nondominant eye. Whether one should always place the measuring prism before this eye is perhaps not so important. It does not seem important that ductions be measured with the prism before the nondominant eye, as such a procedure is of a different nature than that involving the use

of Maddox rod. The result in this series of cases suggests some difference in the readings, but more data are necessary to substantiate it.

In the matter of incorporating a prism into the lens, it does not seem necessary to place it always before the less dominant eye. To create disadvantages, such as a heavier and a more unsightly glass on one side, is a point worth considering and one that is not offset by the questionable value of placing all of the prism before the nondominant eye. Dominancy should not be influenced by the action of the prism, because the prism does not interfere with or impede the dominant eye as would the Maddox rod.

It seems practical to consider the alinement of reading matter. This is especially true when a bifocal correction is prescribed.

There is some evidence which points to the importance of maintaining the dominant eye as the master eye. The operative phase of this subject is but suggestive and perhaps of no practical value. The test for malingering may have some merit.

CONCLUSION

This work has but one object, namely, to stimulate interest in the subject of ocular dominancy. Whether ocular dominancy is but an interesting fact or is of definite clinical importance is as yet unknown. The apparent indifference of ophthalmologists toward the subject suggests the former. This study of the problem was undertaken in a very skeptical frame of mind, because it is believed that only with such an attitude can the results be conservatively evaluated. Many factors suggest that it is worthy of further consideration, and if this presentation serves to stimulate some interest in ocular dominancy it will have served its purpose.

ABSTRACT OF DISCUSSION

DR. DERRICK T. VAIL JR., Cincinnati: For years the term "dominant eye" has created interest and speculation. As Dr. Fink has said, most of the investigations regarding the subject have been carried out by nonmedical workers. This is the first attempt by a trained ophthalmologist to make an exhaustive study. That his patience and interest should have survived long enough for him to make this most complete and overwhelming study is a credit and testament to his scientific sense. Unfortunately, when all the evidence is evaluated, one seems to be back at the starting place.

A study of Dr. Fink's paper suggests that it is not the eye that is dominant but rather the hemisphere of the brain. After-image tests support this contention, a point not sufficiently emphasized by Dr. Fink, I think. If this were so, it would explain the combination of eyedness and handedness. In the development of the race, survival depended on fighting ability. With the shield protecting the heart and held by the left hand, the right eye was used as the sighting eye in throwing a spear with the free, or right, hand.

The usefulness of the test for ocular dominancy in malingering deserves more attention. If the dominant eye, or its determination, were important in any realm save that of sport, its clinical demands, I feel sure, would have become manifest before this.

The subject is exceedingly interesting from a speculative point of view, and ophthalmologists are indebted to Dr. Fink for his careful and thorough investigation of the subject.

Clinical Notes

A MODIFICATION OF THE IRIDENCLEISIS TECHNIC

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In performing iridencleisis I have found some difficulty in reversing the tongue of iris after the meridional incision has been made. Because of this, undue manipulation of the iris is necessitated, with an attendant loss of pigment. Since it is most important for the success of this operation to obtain a pigment-lined cicatrix in the scleral section, all possible means for preventing loss of pigment must be utilized.

Figure 1

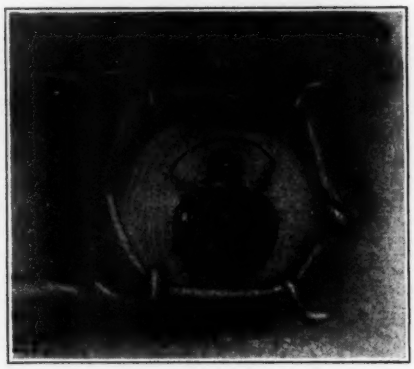

Figure 2

Fig. 1.—Drawing showing the iris pulled out of the wound and the two meridional cuts, one on either side of the forceps, from the pupillary border to the periphery, made with blunt-pointed scissors. The first cut through the iris is indicated by the dash line, and the second cut, by the line along the right side of the forceps.

Fig. 2.—Drawing showing the oblong tongue of iris placed on the sclera with the pigmented surface up.

The following procedure is a simple modification of the Holth technic, which minimizes the manipulation of the iris and conserves the epithelium: After the iris is grasped at the pupillary border and drawn out of the wound, two meridional cuts are made, one on either side of the forceps. The resulting oblong flap of iris can then easily be laid out on the sclera like an apron, pigmented surface up, with a modicum

Read before the Clinical Society of the Herman Knapp Memorial Eye Hospital, Dec. 23, 1937.

of manipulation. The advantages of this simple modification are as follows: 1. A broader base is obtained for the filtering scar. 2. The tongue of the iris is everted and placed on the sclera with ease. 3. The pigment epithelium is retained. 4. There is no tendency for the tag of the iris to retract into the anterior chamber. 5. The pillars of the iris are not drawn into the wound, and a keyhole pupil results.

KERATITIS SICCA

Report of a Case

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Lack of tears leads to dryness of the eyes and to a clinical condition variously described as keratitis sicca, keratoconjunctivitis sicca or keratitis filamentosa. The symptoms are stickiness of the lids and burning and painful sensations, often most intense on awakening. Any disease that destroys the lacrimal gland or its innervation can cause this difficulty. The most satisfactory treatment available was proposed by Beetham [1] in 1935, that is, closure of the canaliculi by electrocoagulation. I have found that after closure of the canaliculi instillation of artificial tears adds further to the comfort of the patient. Keratitis sicca is an uncommon disease, occurring usually among women after the menopause. The symptoms persist for many years; sometimes slight remissions occur. Without treatment, patients with this condition find that any use of their eyes causes discomfort.

REPORT OF CASE

A girl aged 17 years came to the clinic in April 1935 with the complaint of pain and a sensation of scratching in her eyes. The symptoms had been present for three years in the left eye and for three months in the right. Six months before the onset of these symptoms, swelling of the left side of her face occurred. It lasted about two weeks and recurred several times during the next few months. Then the left eyelids became swollen for a week. Thereafter, painful swelling recurred every few weeks, lasting from one to two weeks and involving either the right or the left side of the face or the left eyelids. On a few occasions the right and left submaxillary regions had been swollen. The patient could not recall that fever accompanied the condition; other parts of the body were not involved. Apparently, chronic infection of the lacrimal and salivary glands was present.

Examination revealed the presence of filamentary keratitis. In the lower cul-de-sac there were threads of mucus, and attached to the cornea there were a dozen or more strands of epithelium, from 2 to 6 mm. in length. Fluorescein stained the cornea in numerous discrete and confluent punctate regions. These signs and the intensity of the symptoms varied greatly from week to week. Carotene in oil instilled three times a day gave the patient partial relief during the next two years.

From the Section on Ophthalmology, The Mayo Clinic.

1. Beetham, W. P.: Filamentary Keratitis, Tr. Am. Ophth. Soc. **33**:413-435, 1935.

The lacrimal secretion was greatly diminished, measured according to the method of Schirmer. The secretion from the right eye moistened a strip of filter paper 5 mm. wide for a distance of 5 mm., and that from the left eye moistened a similar strip for a distance of 4 mm. The filter paper was in contact with the secretion for five minutes. The secretion from normal eyes moistened such a strip more than 10 mm. of its length in this time.

In August 1937, according to the suggestion of Beetham, the canaliculi of the left eyelids were closed by means of electrocoagulation. Although the ulcers and filaments were fewer after this procedure, enough remained to keep the patient uncomfortable. It was evident that the flow of tears was practically nonexistent, so that even after the canaliculi were closed there were not enough tears to keep the eye moist. The patient was then told to instil into the left eye, three times a day, a solution resembling tears in composition; this mixture consisted of Locke's solution to which was added enough of the patient's blood serum to make a 10 per cent solution of her serum. After instillation of these substitute tears, within forty-eight hours all ulcers and filaments had disappeared, and the patient was comfortable. The next month the canaliculi of the right eyelids were closed by means of electrocoagulation. The following day no filaments and only a few punctate ulcers were present. Apparently, on the right side there was almost enough lacrimal secretion to keep the eye moist when the drainage of tears was blocked. Even after closure of all four canaliculi the patient complained that her eyes felt sticky and painful on awakening in the morning. Instillation of the artificial tears gave quick relief. Use of the drops three times a day in the left eye and twice a day in the right has kept her entirely comfortable.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

TREATMENT OF CONJUNCTIVITIS

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In this review an attempt will be made to summarize the methods of treatment which are in general use or have been advocated for the more common forms of conjunctivitis.

It is difficult to evaluate these methods, owing to the dearth of well controlled clinical researches on conjunctivitis and the impossibility of estimating with any degree of accuracy the value of therapeutic procedures as tested in ordinary practice in the office or in the clinic. Opinion concerning the treatment of acute and subacute catarrhal conjunctivitis, which are characteristically self limited, must inevitably be questioned; only with chronic conjunctivitis, which shows no tendency to spontaneous cure, or in special types of conjunctivitis the clinical course of which can be predicted may therapeutic efficacy safely be estimated. In view of the manifest difficulties inherent in therapeutic research on the conjunctiva, it is felt that all reports should be examined critically.

PRODUCTION OF CONJUNCTIVAL INFLAMMATION BY BACTERIA AND OTHER AGENTS

An understanding of the underlying mechanism by which bacteria and other agents induce conjunctivitis is essential to an evaluation of therapeutic measures.

Bacteria.—It is believed that bacteria have no mechanical action on the conjunctiva and that their action is entirely chemical, arising from the liberation of soluble toxic products. Pathogenic bacteria may be disease producing while proliferating as follows: (1) superficially, (2) on living epithelial cells or (3) beneath the epithelium.

Bacteria proliferating superficially in the mucous film on the surface of the conjunctiva or on desquamated epithelial cells (e. g., in conjunctivitis due to the Morax-Axenfeld bacillus) liberate toxins (exo-

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toxins and endotoxins) which are believed to diffuse through the epithelium, damaging the cells and producing inflammation. The leukocytic response varies according to the chemotactic effect of the particular toxin concerned. The toxins of Staphylococcus aureus, for example, generally produce a marked neutrophilic response, while the toxins of Haemophilus lacunatus (Morax-Axenfeld) and of Neisseria catarrhalis produce little or no response. The type and degree of the toxic stimulus also determine the degree of cellular infiltration of the conjunctiva and the type of hypertrophy, whether follicular or papillary.

Bacteria proliferating on living epithelial cells (e. g., in conjunctivitis due to the Koch-Weeks bacillus) have been shown by Lindner [1] and by Howard [2] to attach themselves to living cells as soon as they enter the conjunctival sac and to form, by multiplication, a turflike growth in a single layer, each organism being attached to the cell. The infection spreads as the bacteria detach themselves from the original foci to produce new ones. Eventually, in a severe infection, the entire conjunctiva, both palpebral and bulbar, becomes involved. The exotoxins of the bacteria bring about a dissolution of intercellular cement substance, which enables the organisms to penetrate into the deeper layers of the epithelium.

Bacteria proliferating beneath the epithelium (e. g., in gonorrheal endogenous conjunctivitis) reach the subepithelial layers of the conjunctiva generally by way of the blood stream. Occasionally, however, an exogenous infection may occur: Tuberculous conjunctivitis in some cases appears to be a primary exogenous infection, and Verhoeff [3] expressed the belief that the leptothrix which he has described as the cause of Parinaud's conjunctivitis reaches the subepithelial tissues through the epithelium.

Viruses.—It is believed that viruses liberate toxins much as bacteria do, although there are as yet no well esablished data available. It is probable that they multiply only within living cells, some only in the epithelium (e. g., the virus of trachoma and of inclusion conjunctivitis) and others in other tissues as well (e. g., the virus of herpes simplex and of herpes zoster).

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1. Lindner, K.: Ueber die Topographie der Bindehautkeime, Ztschr. f. Augenh. **42**:11, 1919; Ueber die Topographie der parasitären Bindehautkeime, Arch. f. Ophth. **105**:726, 1921.

2. Howard, H. J.: Rôle of the Epithelial Cell in Conjunctival and Corneal Infections, Tr. Am. Ophth. Soc. **22**:186, 1924.

3. Verhoeff, F. H.: Parinaud's Conjunctivitis: A Mycotic Disease Due to a Hitherto Undescribed Filamentous Organism, Arch. Ophth. **43**:145, 1913. Verhoeff, F. H., and King, M. J.: Leptotrichosis Conjunctivae (Parinaud's Conjunctivitis), ibid. **9**:701 (May) 1933.

Allergy.—Allergic conjunctivitis is believed to be the result of injury to the cells of the conjunctiva by an antigen-antibody reaction occurring on or in those cells by which antibody has been fixed.[4]

DEFENSIVE REACTIONS OF THE CONJUNCTIVA

Therapy should work in harmony with the natural defenses of the conjunctiva whenever possible. These defenses have been considered in some detail by Howard[5] and may be summarized as follows:

Defenses of the Normal Conjunctiva.—Lysozyme: Fleming[6] in 1922 showed that tears contain a ferment, which he called lysozyme, capable of dissolving many strains of bacteria, particularly those derived from the air. It is believed that this enzyme plays an important role in maintaining the relatively bacteria-free condition of the normal conjunctiva. What effect it may have on pathogenic bacteria is not yet known.

Phagocytosis: Under normal conditions the polymorphonuclear leukocytes probably play a role in the destruction of bacteria. They can usually be demonstrated in small numbers on the normal conjunctiva in epithelial scrapings.

Preformed Antibodies: Antibodies formed as a result of previous exposure to bacteria or their products probably play a protective role in certain cases by neutralizing bacterial toxins or by stimulating phagocytosis by leukocytes (opsonins); e. g., the immunity of the conjunctivas of most persons to Corynebacterium diphtheriae is due to circulating diphtheria antitoxin previously formed as a result of natural or artificial contact with diphtheria toxin.

Defenses of the Diseased Conjunctiva.—Mechanical Defenses: Lacrimation. The continuous irrigation of the conjunctival sac probably tends to wash away bacteria and to make it difficult for them to gain a foothold on the conjunctiva. In the presence of inflammation the flow of tears is increased and tends to remove all loose bacteria by passage into the nose.

Exfoliation of epithelial cells. Bacterial toxins effect dissolution of intercellular cement substance, cellular edema and increased proliferation of the basal layers, processes which in turn accelerate the normal desquamation of cells. When bacteria proliferate on the cells, this dequamation probably contributes to their removal.

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4. Topley, W. W., and Wilson, G. S.: Principles of Bacteriology and Immunity, Baltimore, William Wood & Company, 1936, p. 897.

5. Howard, H. J.: Offensive and Defensive Factors in Mechanism of Acute Infections of Mucous Membranes, J. Kansas M. Soc. **33**:236, 1932.

6. Fleming, A.: On a Remarkable Bacteriolytic Element Found in Tissues and Secretions, Proc. Roy. Soc., London, s.B **93**:306, 1922.

Hyperemia and edema. With the development of conjunctival inflammation there occurs an oozing of serum and cells, which forms a current against which the bacteria must grow to penetrate the epithelium. Numerous bacteria are carried by this current into the conjunctival sac.

Biologic Defenses: Resistance of repaired tissues. Howard [5] expressed the belief that destroyed epithelium is replaced by new epithelium, which is more resistant than the old.

Phagocytosis by epithelial cells. Lindner [1] and Howard [2] called attention to the fact that in certain acute infections, such as gonorrheal ophthalmia and Koch-Weeks conjunctivitis, the conjunctival epithelial cells phagocytose and digest the bacteria; they expressed the belief that this behavior constitutes a major conjunctival defense.

Immunologic Defenses: Antibodies. It is doubtful if the development of antibodies plays any role in the natural healing of catarrhal conjunctivitis. Bacteria located either on the surface or in the epithelium are, immunologically speaking, outside the body and do not detectably stimulate the formation of immune bodies. Thus it has been found [7] impossible experimentally to immunize rabbits by instillation of staphylococcus exotoxin into the conjunctival sac, although immunization by intracutaneous injection has been successful. Bacteria located subepithelially, however, may immunize; e. g., agglutinins for Pasteurella tularensis usually develop in cases of tularemia of the oculoglandular type within a week.

Specific local immunity. No evidence has been advanced to indicate that the conjunctiva is capable of developing a specific immunity not shared by the body as a whole.

Nonspecific local immunity. The development of a resistance due to the mobilization of tissue histiocytes [8] is well known. It is nonspecific.

ROLE OF THE LABORATORY IN THE MANAGEMENT OF CONJUNCTIVITIS

The value of an etiologic diagnosis in treating such special diseases as diphtheritic and gonorrheal conjunctivitis is readily apparent. It is less so in cases of acute and subacute conjunctivitis, which are self limited, but again in cases of chronic conjunctivitis determination of the etiology may be of real value in the selection of therapeutic measures; when knowledge of the cause is valueless therapeutically, as in cases of inclusion blennorrhea, it may serve prognostically.

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7. Thygeson, P.: Bacterial Factors in Chronic Catarrhal Conjunctivitis, Arch. Ophth. **18**:373 (Sept.) 1937.

8. Topley and Wilson,[4] p. 931.

TABLE 1.—*Laboratory Findings in the Principal Types of Conjunctivitis*

Type of Conjunctivitis	Culture	Secretion Smears	Epithelial Scrapings
Hyperacute conjunctivitis	N. gonorrhoeae; rarely N. meningitidis (ascitic fluid-blood agar)	Positive	Positive
Acute and subacute conjunctivitis	Probable causal bacteria: D. pneumoniae, H. influenzae, H. conjunctivitidis (Koch-Weeks), Staph. aureus, Str. haemolyticus and others	Positive	Often positive
Chronic catarrhal conjunctivitis	Probable causal bacteria; principally Staph. aureus and H. lacunatus (Morax-Axenfeld)	Often negative	Usually positive
Lacrimal conjunctivitis	Causal bacteria: D. pneumoniae, H. influenzae and others	Usually positive	Usually negative
Trachoma	Negative in cases without complications; positive in cases of secondary infection	Negative	Prowazek-Halberstädter inclusion bodies in the early stages and in cases of severe involvement
Inclusion conjunctivitis	Negative	.....	Inclusion bodies in cases in the early stage
Acute follicular conjunctivitis (Béal)	Negative	Mononuclear cellular exudate	Mononuclear cellular exudate
Chronic follicular conjunctivitis	Negative	Negative	Negative
Folliculosis	Negative	Negative	Negative
Prexerosis	.....	.....	Keratinized epithelium and B. xerosis in bulbar scrapings
Pseudomembranous conjunctivitis	C. diphtheriae or Str. haemolyticus; rarely others	.....	.....
Ocular pemphigus	.....	.....	Eosinophilia commonly present
Vernal catarrh	.....	.....	Eosinophilia
Allergic conjunctivitis	.....	.....	Eosinophilia
Keratoconjunctivitis due to rosacea	Staph. aureus often found	.....	.....
Phlyctenular keratoconjunctivitis	Staph. aureus or H. lacunatus (Morax-Axenfeld) often found	.....	.....
Parinaud's conjunctivitis	Leptothrix (Verhoeff) demonstrated on biopsy by special stain and culture		
Oculoglandular type of tularemia	Agglutination test for Past. tularensis positive usually after first week		
Molluscum conjunctivitis	Elementary bodies demonstrated by Löffler's flagella stain of expressed core of molluscum nodule		
Tuberculous conjunctivitis	Tubercle bacilli usually demonstrated in scrapings from ulcers; guinea-pig inoculated with material obtained at biopsy		

The etiology can often be inferred from specific conjunctival changes and occasionally in cases of catarrhal conjunctivitis by a knowledge of the types of conjunctivitis prevailing in the region. Under ordinary circumstances, however, laboratory examination is indicated as follows:

(*a*) In cases of pseudomembranous conjunctivitis, to distinguish between diphtheritic, streptococcic and other infections.

(*b*) In cases of hyperacute conjunctivitis, for the diagnosis of gonococcic infection.

(*c*) In cases of acute follicular conjunctivitis, to distinguish between the Béal type and that due to the inclusion virus.

(*d*) In all cases of ophthalmia neonatorum, to differentiate gonorrheal conjunctivitis from inclusion blennorrhea and nongonorrheal bacterial infections.

(*e*) In cases of trachoma, to determine the presence or absence of secondary bacterial infection.

(*f*) In cases of chronic catarrhal conjunctivitis, to determine whether the infection is due to Staph. aureus or to the Morax-Axenfeld bacillus.

(*g*) In cases of chronic conjunctivitis associated with itching, for the determination of eosinophilia as an indication of allergy.

(*h*) In cases of vernal catarrh, to confirm the clinical diagnosis by demonstrating eosinophilia.

The ophthalmologist should interpret his laboratory findings with considerable caution, keeping the clinical picture in mind at all times. The occurrence of a particular bacterium does not necessarily mean that it is the cause of the conjunctivitis. When such organisms as C. diphtheriae, Neisseria gonorrhoeae, Neisseria meningitidis and Haemophilus conjunctivitidis (Koch-Weeks) are found they may be considered etiologic forthwith, but the relation of such facultative organisms as Staph. aureus, Escherichia coli and Diplococcus pneumoniae must be questioned in the light of the clinical disease. Pathogenicity may be assumed for D. pneumoniae, for example, if it is found in cases of acute catarrhal conjunctivitis, or for Staph. aureus if it is found in cases of chronic blepharoconjunctivitis. That the bacteria may be playing a secondary role must always be borne in mind; any of the bacteria producing catarrhal conjunctivitis may secondarily infect trachoma and other specific diseases.

The important laboratory findings for the principal types of conjunctivitis are summarized in table 1.

A CONSIDERATION OF THERAPEUTIC AGENTS

Bactericidal and Bacteriostatic Agents.—In considering antiseptics for use on the conjunctiva, the following points should be kept in mind:

1. Bactericidal activity in the presence of organic matter (serum and cells)
2. Irritative action
3. Effect of dilution
4. Effect of hydrogen ion concentration
5. Nonspecific actions
   (*a*) Desquamation of epithelium
   (*b*) Stimulation of phagocytic activity of epithelial cells
   (*c*) Chemotactic effect on leukocytes
   (*d*) Effect on lysozyme
6. Type of infection in which the agent is to be employed

Numerous studies have been made on the germicidal power of various antiseptics in vitro, but there is unfortunately almost no information available regarding their action in cases of conjunctivitis. At the time of writing there appears to be no one antiseptic with outstanding advantages. The one most commonly used, silver nitrate, probably

depends for much of its efficacy on nonspecific activity, in particular on its desquamative action, which would appear to make it especially valuable in the treatment of those types of conjunctivitis in which the bacteria invade the epithelium (e. g., gonorrheal ophthalmia and Koch-Weeks conjunctivitis). It is doubtful, however, if any antiseptic used locally contributes materially to the sterilization of the conjunctiva when the bacteria are actually in or beneath the epithelium. Antiseptics are probably most useful in the treatment of those conjunctival inflammations in which the bacteria proliferate in the mucous film on the surface of the conjunctiva, as is the case in conjunctivitis due to the staphylococcus or to the Morax-Axenfeld bacillus. But even if the bacteria are superficial and are destroyed by the antiseptic, a reservoir of organisms may remain in the lacrimal sac, on the margins of the lid or in the meibomian glands, and reinfection of the conjunctiva may readily take place. In cases of papillary hypertrophy, too, the bacteria, although not in the epithelium, may be harbored in the clefts and pseudoglands which are formed.

The value of irrigations in the treatment of conjunctivitis has not been sufficiently investigated, but since the efficiency of antiseptics is definitely reduced by organic material, irrigation prior to the use of the antiseptic would seem to be indicated. The efficiency of the antiseptic may also be reduced if it fails to cover the entire conjunctiva when applied. This will frequently be the case if the antiseptic is instilled into the conjunctival sac, usually the lower fornix, or if applied only to the palpebral conjunctiva. An irritating antiseptic is rapidly diluted by tears.

In some respects ointments are superior to aqueous solutions: They remain in the conjunctival sac longer, they can be used in higher concentrations and they resist dilution. Their interference with drainage, on the other hand, is believed by some ophthalmologists to render them undesirable.

The ideal conjunctival antiseptic has not yet been discovered. It is generally recognized that the phenol coefficient is not a reliable guide to therapeutic usefulness on mucous membranes, and consequently there have been some attempts to rate antiseptics for toxicity to tissues as well as for their ability to kill bacteria. It is of distinct interest that in three recent studies (Salle, McOmie and Shechmeister,[9] Nye[10] and Thompson, Isaacs and Khorazo[11]) iodine in aqueous solution has been

9. Salle, A. J.; McOmie, W. A., and Shechmeister, I. L.: New Method for the Evaluation of Germicidal Substances, J. Bact. **34**:267, 1937.

10. Nye, R. N.: Relative in Vitro Activity of Certain Antiseptics in Aqueous Solution, J. A. M. A. **108**:280 (Jan. 23) 1937.

11. Thompson, R.; Isaacs, M. L., and Khorazo, D.: Laboratory Study of Some Antiseptics with Reference to Ocular Application, Am. J. Ophth. **20**:1087, 1937.

found to be relatively nonirritating to tissues and at the same time decidedly superior to the commonly employed organic preparations in ability to kill Staph. aureus. It has as yet not received clinical trial in cases of conjunctivitis.

Two chemotherapeutic agents have been advanced for specific use on the conjunctiva: ethylhydrocupreine hydrochloride, specific for the pneumococcus, and zinc sulfate (or chloride), specific for the Morax-Axenfeld bacillus. Ethylhydrocupreine is not in general use for the reasons that pneumococcic infections of the conjunctiva are generally self-limited and that other nonspecific antiseptics apparently shorten the course of the disease quite as effectively. Zinc sulfate has come into general use in the treatment of chronic conjunctivitis for the sake of its astringent properties, although in many parts of the United States, at least, the Morax-Axenfeld bacillus is only rarely found.

A new drug, sulfanilamide (and its dye derivatives which are known as prontosil), has been advanced for use in the treatment of infections due to the beta hemolytic streptococcus. Early reports,[12] both clinical and experimental, have been favorable, but so far there have been no reports on the efficacy of this drug in the treatment of conjunctivitis, owing no doubt to the fact that infections of the conjunctiva due to hemolytic streptococci are rare. There is also clinical evidence[13] that the drug is active against certain other bacteria, particularly the gonococcus and the meningococcus. Gonorrhea which has previously been resistant to therapy has been reported as responding well to a combination of sulfanilamide and fever therapy.[14] The preparation is not entirely harmless, however, and a number of complications, including agranulocytosis, allergic reactions, cyanosis, pyrexia, jaundice, and purpuric and scarlatiniform eruptions, have occurred.

Nonspecific Protein and Fever Therapy.—Foreign protein therapy has come into general use as a valuable therapeutic agent in ophthal-

12. Domagk, G.: Ein Betrag zur Chemotherapie der bakteriellen Infektionen, Deutsche med. Wchnschr. **61**:250, 1935. Tréfouël, J.: Tréfouël, J. (Mme.); Nitti, F., and Bovet, D.: Activité du p-aminophénylsulfamide sur les infections streptococciques expérimentales de la souris et du lapin, Compt. rend Soc. de biol. **120**:756, 1935. Levaditi, C., and Vaisman, A.: L'action préventive du chlorhydrate de 4′sulfamido-2.4-diaminoazobenzene dans l'infection streptococcique expérimentale de la souris, ibid. **121**:803, 1936. Colebrook, L., and Kenny, M.: Treatment of Human Puerperal Infections, and of Experimental Infections in Mice, with Prontosil, Lancet **1**:1279, 1936. Buttle, G. A. H.; Gray, W. H., and Stephenson, D.: Protection of Mice Against Streptococcal and Other Infections by *p*-Aminobenzenesulphonamide and Related Substances, ibid. **1**:1286, 1936.

13. Dees, J. E., and Colston, J. A. C.: Use of Sulfanilamide in Gonococcic Infections: Preliminary Report, J. A. M. A. **108**:1855 (May 29) 1937.

14. Ballenger, E. G.; Elder, O. F., and McDonald, H. P.: Sulfanilamide and Thermotherapy in Gonococcic Infections, J. A. M. A. **109**:1037 (Sept. 25) 1937.

mology. The mechanism of action is not entirely clear, and the actual cause of the beneficial effects which undeniably follow its use has not been established. The following actions have been described:[15] fever, leukocytosis, mobilization of preformed antibodies, increase in the bactericidal power of the blood, general stimulation of the metabolism of all cells, increase in the permeability of the capillaries and increase in the activity of the reticulo-endothelial system.

This type of therapy is established on a firm experimental basis: Animals have shown increased resistance to infection after injections of nonspecific protein, withstanding as much as ten times the normally lethal doses. It appears, furthermore, to be peculiarly adapted to the eye, since ocular infections do not seem to stimulate body defenses as a whole. The fact that it is particularly effective against notoriously heat-sensitive bacteria, such as the gonococcus, would seem to indicate that the production of fever is a major action.

Typhoid vaccine and milk are the proteins most generally employed, although others, such as omnadin (a nonspecific substance containing albumin, lipoid and fat), antidiphtheritic serum and autoserum, have been used. Typhoid vaccine given intravenously has the following advantages: (1) absence of local reaction, (2) ease of administration and (3) relative uniformity of dosage. It is to be recommended for all patients except infants, to whom milk should be given intramuscularly.

Fever induced by electrical means or by heat cabinets has been employed with success in the treatment of syphilis and gonorrhea and should have increasing application in ocular conditions. By these means any desired temperature can be produced and maintained. The mechanism of action seems to be essentially like that of foreign protein.

Immunologic Agents and Procedures.—Vaccine Therapy: This form of therapy is limited theoretically to those conditions in which the existing infection is not providing a satisfactory stimulus to the immunity-building apparatus of the body, i. e., to most infections of the eye. Theoretically, vaccines should be effective against those bacteria which act principally by endotoxins, and autogenous vaccines should be preferable to stock preparations. In practice, however, the usefulness of specific vaccine therapy is limited to staphylococcic infections, and autogenous vaccines have small advantage over stock vaccines. Moreover, it now seems probable that staphylococcus toxoid[16] will supersede the vaccine.

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15. Petersen, W. F.: Protein Therapy and Nonspecific Resistance, New York, The Macmillan Company, 1922.

16. Dolman, C. E., and Kitching, J. S.: Tests for Innocuity and Antigenic Potency of Staphylococcus Toxoid, J. Path. & Bact. **41**:137, 1935. Dolman, C. E.: Treatment of Localized Staphylococcic Infections with Staphylococcus Toxoid, J. A. M. A. **100**:1007 (April 1) 1933; Clinical Uses of Staphylococcus Toxoid, Lancet **1**:306, 1935.

Toxins and Toxoids: These therapeutic products are used to produce an active antitoxic immunity against bacteria which act principally by exotoxins. Staphylococcus toxin has been employed with success by Burky [17] in the treatment of local staphylococcic infections of the eye, but toxoid (toxin detoxified by formaldehyde) would seem to be preferable in view of its greater safety and availability. Diphtheria toxoid probably acts prophylactically in preventing diphtheritic conjunctivitis, but it is of no value in treatment. Diphtheritic conjunctivitis is an acute infection and runs its course before an active immunity can be built up.

Antitoxins: This form of therapy is used to produce a passive antitoxic immunity. Diphtheria antitoxin is effective in the cure of conjunctivitis due to C. diphtheriae except in the rare cases in which the infection is mixed with a streptococcic infection. Antimeningococcus antitoxin (Ferry [18]) has recently been shown to be of value in the treatment of meningococcic infections, and Kluever [19] has reported favorable; though not curative, results with scarlet fever antitoxin in a case of pseudomembranous conjunctivitis caused by hemolytic streptococci.

Antibacterial Serums: These serums have been used with limited success to produce passive immunity against bacteria which act principally by endotoxins. An immune serum has been employed in the treatment of tularemia by Kudo [20] and by Foshay.[21]

Tuberculin: The use of tuberculin in the treatment of phlyctenular conjunctivitis and conjunctival tuberculosis has met with questionable success. According to Woods,[22] tuberculin should be used to achieve and maintain tissue desensitization rather than to produce focal reactions.

Desensitization: This form of therapy can be tried in cases of allergic conjunctivitis in which the causal agent is known but cannot be removed from the environment. This has been done in cases of hay fever conjunctivitis with some success and by Waller [23] in cases of sensitivity to atropine.

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17. Burky, E. L.: Studies on the Action of Staphylococcus Toxin and Antitoxin with Special Reference to Ophthalmology, Am. J. Ophth. **19**:841, 1936.

18. Ferry, N. S.: Meningococcus Antitoxin, J. Immunol. **23**:315, 1932. Hoyne, A. L.: Treatment of Meningococcic Infections, Arch. Pediat. **53**:164, 1936.

19. Kluever, H. C.: Streptococcal Pseudomembranous Conjunctivitis, Am. J. Ophth. **18**:1094, 1935.

20. Kudo, M.: Studien über das Bakteriumtularense, Jap. J. Exper. Med. **12**:377, 1934.

21. Foshay, L.: Tularemia Treated by a New Specific Antiserum, Am. J. M. Sc. **187**:235, 1934.

22. Woods, A. C.: Treatment of Ocular Tuberculosis, Tr. Am. Ophth. Soc., 1937, to be published.

23. Waller, R. G.: Atropine Irritation and Its Prevention, Tr. Ophth. Soc. U. Kingdom **54**:96, 1934.

Physical Therapy.—Heat: The application of heat produces an active hyperemia with increased resistance to infection but is of little value in the treatment of conjunctivitis. Heat should not be employed locally in cases of gonorrheal ophthalmia unless maintained in sufficient degree to be bactericidal; as ordinarily employed, it increases the temperature of the conjunctiva just enough to favor the growth of the gonococcus.

Cold: The application of cold produces constriction of the small vessels and is useful in lessening the swelling in the early stages of conjunctival inflammations. It is employed in the early stages of gonorrheal ophthalmia and after expression operations in cases of trachoma. Brown [24] cautioned against the direct use of ice, applied even through closed eyelids, because of its damaging effect on the cornea; McKee [25] recommended the use of pads chilled on a block of ice and frequently changed.

Ultraviolet Rays: Phototherapy has been employed in cases of chronic conjunctivitis and blepharitis, but its greatest value appears to be (1) in cases of tuberculous conjunctivitis (many cures with the Finsen lamp have been reported [26]) and (2) in cases of phlyctenular conjunctivitis, in which general rather than local phototherapy is employed. Laws [27] has employed ultraviolet rays to rid the conjunctiva of bacteria preoperatively.

A consideration of the mechanism of the action of the ultraviolet rays may be found in the recent handbook by Gifford [28] and in the article by Brown [24] in Berens' "The Eye and Its Diseases." The ultraviolet rays are known to be bactericidal in effect, to stimulate the formation of vitamin D in the body, to increase the bactericidal power of the blood and to produce a local hyperemia. They must be employed with some caution to avoid the possibility of damage to the cornea and lens.

Radium and X-Ray: Radium has been employed with some success in the treatment of severe vernal catarrh, but the occurrence of late

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24. Brown, A. L., in Berens, C.: The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, p. 1014.

25. McKee, S. H., in Berens, C.: The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, p. 384.

26. François, J.: Etude sur la conjonctivite tuberculeuse du type folliculaire, Bull. Soc. belge d'opht., 1934, no. 68, p. 46. Blegvad, O.: Demonstration af patienter med tuberculosis conjunctivae, Hospitalstid. **78**:63, 1935. Neame, H.: Conjunctival Tuberculosis with Report of Unusual Case, Tr. Ophth. Soc. U. Kingdom **54**:76, 1934. Wittels, L.: Klin. Oczna **12**:486, 1934.

27. Laws, F. W.: Present Status of Ultra-Violet Light Therapy in Eye Disease, Tr. Ophth. Soc. U. Kingdom **53**:201, 1933.

28. Gifford, S. R.: Ocular Therapeutics, ed. 2, Philadelphia, Lea & Febiger, 1937, p. 103.

changes in the lens, presumably due to the radium, has led some ophthalmologists to abandon its use. Roentgen rays have been recommended by Gifford [29] for the treatment of intractable chronic conjunctivitis, blepharitis and dermatitis of the lids. A description of the biologic actions of radiotherapy is to be found in the recent article by Desjardins.[30] According to him, many forms of acute inflammation yield rapidly to a single small dose of roentgen rays. The dose must never exceed 80 per cent of an erythema dose; otherwise conjunctivitis or late degeneration of the crystalline lens may follow. This is especially likely to occur in children.

Massage: In cases of chronic conjunctivitis with infection of or overactivity of the meibomian glands massage is often helpful. The accumulated material in the ducts is expressed by massage of the lids accomplished by pressing with the two thumb nails on the cutaneous side of the two lids, which are held together and away from the globe. It is probable that the benefit derived from chaulmoogra oil in cases of trachoma is due in large part to the brisk massage employed in administering it.

Astringents.—Astringents have been employed in cases of chronic conjunctivitis, particularly in those of unknown etiology. Silver, zinc and copper salts have been found most useful, but alum and tannic acid have also been employed. Silver nitrate and copper sulfate when used in desquamating doses usually give symptomatic relief. The mechanism of action is not well understood but is associated with the removal of superficial epithelial cells.

Vasoconstrictors.—Preparations such as epinephrine hydrochloride (1:1,000) and a 3 per cent solution of ephedrine cause blanching of the superficial conjunctival vessels. They are useful in cases of vernal catarrh and of allergic conjunctivitis and are sometimes employed, mixed with mild astringents, such as a 0.25 per cent solution of zinc sulfate, in cases of chronic conjunctivitis. Their effect is entirely symptomatic.

THERAPY

Hyperacute Conjunctivitis.—The principal object of therapy for gonorrheal conjunctivitis is to maintain an intact cornea during the course of the disease. It is of prime importance to avoid trauma to the epithelium of the cornea, as ulceration usually results; competent nursing is therefore essential. Reliance must be placed on foreign

29. Gifford, S. R.: Ocular Therapeutics, ed. 1, Philadelphia, Lea & Febiger, 1932.

30. Desjardins, A. U.: Radiotherapy (Roentgen Rays; Radium), J. A. M. A. **105**:2064 (Dec. 21) 1935.

protein or fever therapy and irrigations; local antiseptics are of minor importance, since the gonococci rapidly invade the epithelium and become inaccessible.

Fever is conveniently induced by intravenous injections of typhoid vaccine, 30,000,000 bacilli being the usual dose required to produce a temperature of from 102 to 105 F. in the adult. This dose is doubled on succeeding injections, which may be given every day or every other day over a period of a week or ten days. Injections of milk should be used for infants, 1 cc. of boiled whole milk being given intragluteally at first, with an increase in the dose on subsequent injections to produce the required reaction.

Artificial fever induced by short wave diathermy or other electrical means or by the air-conditioned cabinet has been successful in the treatment of gonorrheal urethritis and of gonorrheal arthritis [31] and will no doubt be applied generally in cases of gonorrheal conjunctivitis [32] in the larger institutions. A high temperature is maintained over a sufficiently long time for the fever to be gonococcicidal.

Irrigations of boric acid solution or physiologic solution of sodium chloride should be used as frequently as necessary to remove secretion and with care to prevent corneal abrasions. Mild antiseptics may be instilled. Cold compresses may be employed in the early stages if swelling is extreme; the use of hot compresses is not recommended. Gifford [33] recommended the use of conjunctival flaps when large ulcers develop.

In cases of unilateral conjunctivitis the unaffected eye should be protected by means of a Buller shield or a similar apparatus.

The return of the conjunctiva to normal after disappearance of the gonococci can probably be hastened by the use of an astringent, such as zinc sulfate or copper sulfate.

Gonococcus filtrate (Corbus-Ferry) has been employed with some success in cases of chronic gonorrhea. Although a favorable result has been reported by Storts [34] in a single case of ophthalmia neonatorum, it seems improbable on theoretical grounds that the filtrate will prove of value in the treatment of this disease.

Endogenous gonorrheal conjunctivitis is not uncommon and occurs in persons who have systemic gonorrhea. It is usually benign and responds well to fever therapy. It is of great importance to recognize

31. Owens, C. A.: Value of Fever Therapy for Gonorrhea, J. A. M. A. **107**:1942 (Dec. 12) 1936.

32. Pinkerton, F. J.: Hyperthermic Treatment for Acute Gonorrheal Ophthalmia, Am. J. Ophth. **20**:63, 1937.

33. Gifford,[28] p. 171.

34. Storts, B. P.: Ophthalmia Neonatorum Treated with Gonococcus Filtrate (Corbus-Ferry), Arch. Pediat. **52**:567, 1935.

and treat the iritis which usually accompanies it. Sulfanilamide should receive clinical trial for both forms of gonorrheal conjunctivitis.

The meningococcus has recently been recognized [35] as an occasional cause of severe conjunctivitis; it is possible that in the past meningococcic conjunctivitis has been confused with gonorrhea in some cases. No specific treatment has as yet been formulated, but the antibacterial or antitoxic serums which have proved of value in cases of meningococcic meningitis should be tried; the effect of fever therapy has not yet been determined. In other respects the disease should be treated like gonorrheal conjunctivitis.

Acute and Subacute Catarrhal Conjunctivitis.—In most cases of acute and subacute catarrhal conjunctivitis healing occurs spontaneously, but antiseptic treatment can probably shorten the course (questioned by Howard [36]). Silver nitrate has withstood the test of time and deserves first place in the list of antiseptics. The solution in 1 or 2 per cent concentration may be applied to the everted lids, followed by irrigation with physiologic solution of sodium chloride. Mild antiseptic collyria may be prescribed for use at home. Silver nitrate ointment (0.5 per cent) has been used with success in O'Brien's clinic at the University of Iowa, and in my opinion is to be preferred to the aqueous solution, since it reaches the bulbar conjunctiva on which bacteria, particularly the Koch-Weeks bacillus and the pneumococcus, are known to be most numerous. It has the further advantage that it may be conveniently prescribed for use at home.

From the clinical data available, there appears to be little choice among the other common antiseptics. Since the activity of all of them is reduced in the presence of organic matter, preliminary cleansing of the conjunctival sac by irrigation is advisable. In cases in which the cause is the pneumococcus, a freshly prepared 1 per cent solution of ethylhydrocupreine hydrochloride used three times daily is effective.

Chronic Catarrhal Conjunctivitis.—In table 2 is summarized graphically the treatment for some of the forms of chronic conjunctivitis. It is of utmost importance to establish the cause whenever possible.

Chronic Conjunctivitis Due to H. Lacunatus (diplobacillus of Morax and Axenfeld): This type is best treated with zinc compounds; the sulfate, employed in from 0.125 to 0.5 per cent solution, is the most popular. A satisfactory routine is to use the 0.25 per cent solution as a collyrium

35. Reese, F. M.: Meningococcus Conjunctivitis Followed by Septicemia and Beginning Meningitis, Am. J. Ophth. **19**:780, 1936. Gifford, S. R., and Day, A. A.: Acute Purulent Conjunctivitis Due to the Meningococcus: Report of a Case, Arch. Ophth. **13**:1038 (June) 1935.

36. Howard, H. J.: Rationale of Treatment in Some Acute Conjunctival Infections, J. Missouri M. A. **29**:193, 1932.

three times daily and to apply the 0.5 per cent ointment to the margins of the lids at night. It is of great importance to treat the margins of the lids, a favorite site of multiplication of the diplobacilli, and to continue the treatment for at least a month after symptoms have subsided in order to prevent recurrence. In my experience the rare cases in which there has been no response to this treatment have been those in which the infection was of the mixed type, Staph. aureus usually being the associated bacterium.

TABLE 2.—*Treatment for Some Forms of Chronic Conjunctivitis*

Minute Clinical Examination
Slit-Lamp Examination of Cornea

Simple types

Pathogenic bacteria present

1. Conjunctivitis due to Staph. aureus
   (a) Antiseptics
   (b) Treatment of margins of lids
   (c) Staphylococcus toxoid
2. Conjunctivitis due to diplobacillus of Morax and Axenfeld
   (a) 0.25% solution of zinc sulfate to conjunctiva
   (b) 0.5% zinc sulfate ointment to margins of lids
   (c) Continue treatment 3 months
3. Conjunctivitis caused by other bacteria (principally D. pneumoniae and N. catarrhalis)
   (a) Antiseptics

No pathogenic bacteria

1. Allergic conjunctivitis
   (a) Removal of cause whenever possible
   (b) Symptomatic treatment:
      (1) Epinephrine
      (2) Copious irrigations
2. Conjunctivitis of unknown etiology
   (a) Antiseptics
   (b) Astringents
   (c) Miscellaneous
      (1) Phototherapy
      (2) Expression of material from meibomian glands
      (3) Correction of refractive errors

Special types

1. Superficial punctate keratoconjunctivitis
   (a) Treatment unsatisfactory
2. Keratoconjunctivitis due to acne rosacea
   (a) Treatment unsatisfactory
3. Keratoconjunctivitis sicca
   (a) Sealing of canaliculi
   (b) Vitamins
4. Prexerosis
   (a) Vitamin A
5. Conjunctivitis secondary to streptothrix concretions in canaliculi
   (a) Removal of concretions
6. Conjunctivitis secondary to verucca and mollusca on margins of lids
   (a) Removal of tumors
7. Conjunctivitis secondary to trichiasis, minute foreign bodies, etc.
   (a) Removal of cause
8. Conjunctivitis produced by irritants, such as smoke and vapors
   (a) Removal of cause

Chronic Conjunctivitis Due to Toxin-Producing Staphylococcus: This type of conjunctivitis (usually due to Staph. aureus but occasionally to Staph. albus) frequently resists local treatment. Like the diplobacilli, staphylococci tend to localize on the margins of the lids, which should be treated simultaneously with the conjunctiva. A routine therapy employed with some success at the Vanderbilt Clinic consists of: (1) use of antiseptic collyrium three times daily, (2) application of a 1 per cent solution of silver nitrate to the margins of the lids and of a 0.25 per cent solution to the conjunctiva once or twice weekly, (3) application of a 2 per cent ammoniated mercury ointment to the margins of the lids at night and (4) epilation of lashes if the roots show infection (indicated by thickening and abnormal straightness of the lash and by blackening of its base). If local treatment fails after a trial period

of six weeks or longer, immunization with staphylococcus toxoid is begun. The toxoid is given twice weekly in the dosage recommended by the manufacturer. A small percentage of patients show a hypersensitivity to the preparation, and for them the dose must be reduced. The course may be repeated if necessary.

Chronic Conjunctivitis Due to Other Bacteria: For the most part, this type of conjunctivitis responds well to local treatment. The outstanding exceptions in my experience have been rare cases in which the cause was presumably hemolytic streptococci or Proteus and one case in which Pseudomonas aeruginosa (Bacillus pyocyaneus), Escherichia coli and Klebsiella pneumoniae (Friedländer) were the causative agents. The patient in the latter case has been under treatment by a number of ophthalmologists over a period of five years.

Chronic Conjunctivitis Due to Allergy: This type is gradually being accepted as a clinical entity. Allergy should be looked for in cases in which itching is the most prominent symptom or in which the ordinary treatment aggravates the condition. The presence of conjunctival eosinophilia is an important diagnostic sign. Treatment consists of elimination of the sensitizing agent whenever possible and in the relief of symptoms by local measures: the use of epinephrine and procaine hydrochloride, copious irrigations with boric acid solution and the use of iced compresses. Desensitization is sometimes of value, as in cases of hay fever conjunctivitis.

In many cases of allergic conjunctivitis the offending agent can be found by means of careful study of the history, without recourse to cutaneous tests. Sensitivity to the drugs employed in ophthalmic practice is common; in my experience sensitivity to physostigmine, atropine, butyn, pontocaine, procaine hydrochloride and mercuric preparations has been observed most frequently. Conjunctivitis due to face powder, rouge, hair dye, eyelash dye and other cosmetics is being commonly recognized. Occupational conjunctivitis is likewise not uncommon. The conjunctival manifestations of allergy have recently been considered in an article by Woods.[37]

Chronic Conjunctivitis Due to Acne Rosacea: This type of conjunctivitis has been investigated clinically by Verhoeff.[38] The treatment generally applied, consisting of dietary restrictions (elimination of tea and coffee and other vasodilators) and application of zinc-ichthammol ointment, has not proved satisfactory. When there is complicating bacterial infection it should be treated appropriately.

37. Woods, A. C.: Clinical Problem of Allergy in Relation to Conjunctivitis and Iritis, Arch. Ophth. **17**:1 (Jan.) 1937.

38. Verhoeff, F. H.: Personal communication to the author.

Chronic Conjunctivitis of Unknown Etiology: Astringents, such as zinc sulfate, tannic acid and alum, are generally used in the treatment of this type of conjunctivitis. When there is much discomfort, the removal of the superficial layers of the epithelium by the use of silver nitrate or copper sulfate often gives temporary relief. Gifford [28] has recommended the use of phototherapy, the conjunctiva being subjected to 75 per cent of the erythema dose for the skin of the patient. Treatments are repeated two or three times a week, and more than six treatments are seldom necessary.

According to Gifford,[39] chronic hypersecretion of the meibomian glands may be an etiologic factor in some of these cases owing to the broken-down products of the fatty secretion. He recommended massage of the meibomian glands at intervals for weeks or months. The roles of such conditions as refractive errors and chronic nasal sinusitis are difficult to evaluate, but all such defects should be corrected whenever possible.

By careful clinical study it is often possible to define special types of chronic conjunctivitis which on superficial examination appear nonspecific. Thus there exists a frequently occurring form in which slit lamp examination demonstrates the presence of numerous minute punctate epithelial lesions not visible macroscopically. This condition is generally known as superficial punctate keratitis, although it is not identical with the form described by Fuchs. The lesions heal after running a definite clinical course lasting at least three months; in my experience they have not been affected by treatment. Gifford,[39] who considered the condition to be a mild epithelial dystrophy, recommended the use of ethylmorphine hydrochloride and alkaline washes. He expressed the belief that the administration of vitamin A has been effective in some cases and suggested that the condition may be a mild form of xerosis. It must be remembered that a variety of conjunctival diseases of known etiology also have associated superficial punctate epithelial lesions; so considerable caution must be exercised in their interpretation.

Some cases of chronic conjunctivitis without demonstrable cause are probably in reality instances of mild keratoconjunctivitis sicca,[40] in which deficient lacrimal secretion is the principal sign. The condition is seen principally in women during and after the menopause. Beetham [41] has

39. Gifford, S. R.: Ocular Therapeutics, ed. 2, Philadelphia, Lea & Febiger, 1937.

40. Sjögren, H.: General Symptomatology and Etiology of Keratoconjunctivitis Sicca, Acta ophth. **13**:1, 1935.

41. Beetham, W. P.: Filamentary Keratitis, Tr. Am. Ophth. Soc. **33**:413, 1935.

treated it successfully by sealing off the canaliculi, and von Grósz [42] recommended general treatment with appropriate endocrine preparations and antianemic agents (liver, iron and arsenic) as well as fibrolysin and vitamin A in oil locally. Vitamin A preparations should also be given by mouth.

Prexerosis, due to mild vitamin A deficiency, is sometimes confused with catarrhal conjunctivitis. It responds well to the administration of vitamin A.

Secondary Conjunctivitis.—Conjunctivitis secondary to streptothrix concretions of the canaliculi responds readily to removal of the concretions. This can usually be accomplished with a fine curet without slitting the canaliculus.

According to reports, removal of the tumors in the rare cases of chronic conjunctivitis secondary to warts [43] or molluscum contagiosum [44] of the margin of the lid has brought about a ready response.

Conjunctivitis secondary to mild trichiasis, minute foreign bodies and irritants heals when the cause is removed.

The conjunctivitis which accompanies chronic dacryocystitis usually heals after extirpation of the lacrimal sac or after restoration of normal drainage by probing or by dacryocystorhinostomy. The latter operation is much to be preferred to extirpation.

SPECIAL FORMS OF CONJUNCTIVITIS

Pseudomembranous Conjunctivitis Due to C. Diphtheriae.—This form of conjunctivitis is treated with diphtheria antitoxin in doses varying from 5,000 to 20,000 units, according to the severity of the disease and the age of the patient. It is preferable to give the full amount indicated intramuscularly in a single dose. All local measures are of decidedly secondary importance, but the local instillation of antitoxin has been recommended. It is generally considered best to leave the membrane untouched, as its removal may increase absorption of toxin. The possibility of atypical forms without pseudomembrane formation, as recently reported by François,[45] must be kept in mind.

Pseudomembranous Conjunctivitis Due to Hemolytic Streptococci.—Local treatment appears to be without effect in cases of this type.

42. von Grósz, S.: Aetiologie und Therapie der Keratoconjunctivitis sicca, Klin. Monatsbl. f. Augenh. **97**:472, 1936.

43. Vito, P.: Sulla congiuntivite da verruca del bordo libero delle palpebre, Boll. d'ocul. **15**:627, 1936.

44. Wilczek, M.: Molluscum Contagiosum and Trachoma, Klin. Oczna **12**:711, 1934.

45. François, J.: Catarrhal Diphtheritic Conjunctivitis, Brit. J. Ophth. **19**: 1, 1935.

Kluever [19] found that scarlet fever antitoxin brought about temporary disappearance of the membranes in one case, but the disease recurred. Sulfanilamide [12] has given favorable results in cases of puerperal fever and of other hemolytic streptococcic infections; it should be tried in cases of conjunctivitis of this type.

Ocular Pemphigus.—No treatment so far tried has had any apparent marked effect in cases of ocular pemphigus. A favorable effect from roentgen therapy was reported in one case by Bane,[46] but it failed to modify the disease in three cases under my observation. Arsenic preparations have been administered internally. Gifford [47] recommended the use of a carotene, viosterol and wheat germ oil mixture to supply vitamins A, B and D. Local treatment to combat trichiasis and secondary infection is indicated, and oily solutions may give symptomatic relief after the establishment of xerosis.

Trachoma.—This condition has been considered by some to be incurable, and it is true that at the dispensaries many persons are seen who have had sporadic treatment over many years without result. With regular treatment over a sufficiently long period, however, healing occurs in the majority of cases. The first requirement for success, without which it is useless to attempt therapy, is the absolute cooperation of the patient. He must understand the nature of his disease, its gravity and the probable length of time required for cure. He should be told that in a case in which there are no complications under the best conditions a year will be required, and that ordinarily it will take considerably longer.

The treatment of trachoma is both local and mechanical and varies with the stage of the disease, according to the relative preponderance of follicular or papillary hypertrophy. There is no specific chemotherapeutic agent active against the virus of trachoma, but experience has shown that the frequent application to the conjunctiva of a cauterizing or strongly irritating agent, such as copper sulfate, will in most instances eventually effect healing. The exact mechanism of this action is not known. The mechanical removal of expressible follicular material is of great value in accelerating the healing process and should be repeated whenever follicles reform. A preponderance of papillary hypertrophy indicates a superimposed bacterial infection or, more rarely, trachoma of high activity; daily applications of silver nitrate continued over a period of a week or two are indicated. Mild bacterial infection may be present in any stage of the disease and may be treated by three daily instillations of a mild antiseptic, such as a solution of mercuric oxycyanide in a concentration of 1 : 5,000. The occurrence of blepharitis

46. Bane, W. C.: Personal communication to the author.

47. Gifford,[28] p. 186.

almost invariably indicates either a diplobacillary or a staphylococcic infection and should be treated accordingly.

In spite of the fact that the corneal changes cause the principal disabilities from the disease, no effective treatment for trachomatous pannus has as yet been developed. In general, the corneal changes have been found to regress after regression of the conjunctival lesions, but this is not always true. When the cornea does not heal, interruption of the blood vessels of the pannus surgically or by diathermic coagulation sometimes helps, and the value of zinc peroxide as recommended by Busacca [48] is now being tested by me in daily applications. The results so far obtained have been sufficiently good, particularly in the healing of the ulcers associated with pannus, to warrant further clinical trial. Deep ulcers invariably indicate bacterial infection and should be treated accordingly.

A detailed description of the aforementioned procedures follows:

Copper Sulfate: After preliminary anesthesia induced with a 2 per cent solution of butyn, a 1 per cent solution of pontocaine or some similar anesthetic, the stick is applied gently to the conjunctiva of the lids and fornices after eversion with a lid everter. The excess copper sulfate is removed with boric acid solution or physiologic solution of sodium chloride. The application should be graded to the patient's tolerance. The value of the treatment depends in large part on its frequency: Treatments less than three times weekly are probably of little value, and daily application is much to be preferred. Relatives of patients have been successfully trained to perform the treatments under conditions which have prevented daily visits to the office, and in some instances the patient has been able to treat his own eyes. The use of copper sulfate in an ointment or solution does not seem to be of value.

Silver Nitrate: A 1 per cent solution of silver nitrate is applied to the conjunctiva of the everted lids and fornices by means of a cotton applicator. The excess amount is removed by irrigation with physiologic solution of sodium chloride.

Zinc Peroxide: After local anesthesia, about 0.5 Gm. of zinc peroxide is placed or blown into the fornices, and the lids are kept closed for half an hour. The powder is then removed by irrigation; a cotton applicator is useful in removing small particles which may remain.

Expression of Follicles: Local anesthesia produced by instillations of a 4 per cent solution of cocaine and by the injection into the fornices of a 1 per cent solution of procaine hydrochloride with epinephrine is

48. Busacca, A.: Die trachomatöse avaskuläre Keratitis, Klin. Monatsbl. f. Augenh. **94**:202, 1935.

used for the expression operation. A ring forceps is employed to strip the entire conjunctiva of expressible follicular material. The caruncle and semilunar folds should be similarly expressed; a conjunctival forceps placed through one of the rings of the ring forceps is helpful in grasping the tissues. It is well at the same time to remove the lymphoid accumulation at the upper limbus with a sharp curet. This operation is simple and does not require hospitalization.

Of the many other remedies proposed for the treatment of trachoma, only chaulmoogra oil and quinine bisulfate appear to have gained much popularity. Chaulmoogra oil has been used with success by Gradle and associates [49] in the campaign against trachoma in southern Illinois, but in my experience it has seemed inferior to copper sulfate.

The various cicatricial complications are treated surgically. The combined tarsoconjunctival excision which used to be commonly employed in the treatment of trachoma in all stages is fortunately going out of favor. In Egypt it is used only occasionally. The entropion which occasionally results is difficult to treat, and the shortening of the conjunctiva interferes with the movement of the globe. The employment of such a radical procedure appears to be unjustified.

A large number of remedies for the treatment of trachoma have appeared in the literature in the past few years. Among them may be mentioned cod liver oil,[50] locally applied; roentgen irradiation; [51] a snake and bee venom preparation; [52] iodoform,[53] as a powder or an ointment; mercuric cyanide; [54] benzyl cinnamate; [55] autohemotherapy; [56] massage with lump sugar; [57] ginger; [58] sodium taurocholate; [59] massage

49. Lenzen, A. F., and Gradle, H. S.: Treatment of Trachoma, Am. J. Ophth. **19**:665, 1936.

50. Possenti, G.: L'olio di fegato di merluzzo per applicazione locale in oculistica, Rassegna ital. d'ottal. **5**:96, 1936.

51. Cattaneo, D.: Azione dei raggi roentgen su alcune forme iperplastiche nella congiuntiva tracomatosa, Rassegna ital. d'ottal. **3**:661, 1934.

52. Lobel, A.: A propos d'un nouveau médicament dans le traitement du trachome: "Le trachocid," Ann. d'ocul. **173**:734, 1936.

53. Stiel, A.: Ueber Probleme der Körnerkrankheit (Trachom), Ztschr. f. Augenh. **90**:263, 1936.

54. Shalom, E. S.: Intracorneal Injections of Cyanide of Mercury in Trachomatous Pannus, Brit. J. Ophth. **19**:107, 1935.

55. Jacobson, J.: Use of Benzylester of Cinnamic Acid in Ophthalmology, Sovet. vestnik oftal. **6**:808, 1935.

56. Zacharov, A.: Autohemotherapy in Trachomatous Pannus and Ulcers of the Cornea, Sovet. vestnik oftal. **5**:437, 1934.

57. Murphy, F. G.: Sugar Treatment of Trachoma, Am. J. Ophth. **18**:176, 1935.

58. Solotnitzky, J. N.: Le traitement du trachome à l'aide du gingembre, Rev. internat. du trachome **12**:34, 1935.

59. Paparcone, E.: Sur la diminution du trachome en Italie, Rev. internat. du trachome **12**:202, 1935.

with sodium chloride,[60] and daily scrapings [61] followed by massage with a solution of mercury bichloride in a concentration of 1 : 1,000. Sulfanilamide is now being used in the treatment of trachoma by physicians of the United States Indian Service. It appears to have a favorable effect, particularly in the corneal complications of the disease.

Follicular Conjunctivitis.—This type of conjunctivitis is conveniently considered under the classification proposed by Morax: [62]

1. Follicular conjunctivitis, swimming pool type (inclusion conjunctivitis), heals spontaneously within a year in almost all instances; it is doubtful if treatment of any kind will shorten the course, though Gifford has recommended the use of copper sulfate.

2. Acute follicular conjunctivitis of the Béal type heals within a month. There is no evidence to indicate that treatment shortens the course, but silver nitrate has been employed.

3. Chronic follicular conjunctivitis may require several years for healing. Nothing is known about treating it.

4. Toxic follicular conjunctivitis is an allergic manifestation most commonly due to physostigmine atropine or some other drug.

Folliculosis.—This condition is usually symptomless and requires no treatment. Mild astringents seem to act favorably.

Phlyctenular Conjunctivitis.—General treatment is required for phlyctenular conjunctivitis, since the majority of children who have it are poorly nourished and react positively to tuberculin. An adequate diet supplemented by cod liver oil or concentrates containing vitamins A and D is indicated. General phototherapy is useful. Yellow mercuric oxide or mild mercurous chloride dusted into the eyes daily is commonly employed. The frequent occurrence of pathogenic bacteria on the conjunctiva in these cases has been noted by Axenfeld [63] and McKee; [64] in my experience Staph. aureus has been found in over half the cases observed. The removal of the bacteria by appropriate methods has apparently had a favorable effect on the primary disease.

Vernal Catarrh.—Recent work [65] points to vernal catarrh as an allergic disease, but allergists in general have found it extremely diffi-

60. Shannon, P. A.: Study of Trachoma in Baluchistan, Indian M. Gaz. **69**:672, 1934.

61. Meyerhof, M., and Habachi, S.: D'un mode particulier de traitement des formes rebelles du trachome (le raclage journalier), Rev. internat. du trachome **12**:189, 1935.

62. Morax, V.: Les conjonctivites folliculaires, Paris, Masson & Cie, 1933.

63. Axenfeld, T.: Bacteriology of the Eye, translated by Angus McNab, London, Baillière, Tindall & Cox, 1908.

64. McKee,[25] p. 393.

65. Lehrfeld, L.: Vernal Conjunctivitis, Arch. Ophth. **8**:380 (Sept.) 1932. Woods [37]

cult to determine significant sensitivities. Local treatment is directed to relief of the itching and irritation, so prominent a feature of the disease. Perhaps the most useful of these are copious irrigations with boric acid solution and frequent instillation of a solution of epinephrine hydrochloride (1:1,000).

Parinaud's Conjunctivitis.—This condition runs a definite course, lasting on the average about three months. According to Verhoeff,[66] excision of the most prominent nodules seems to shorten the course of the disease.

Conjunctival Tuberculosis.—The prognosis in most cases of conjunctival tuberculosis is favorable. General antituberculous measures along with local applications of ultraviolet rays [26] seem to have improved the condition. Tuberculin has been employed.

Oculoglandular Type of Tularemia.—An antiserum has been used by Foshay [21] and by Kudo [20] in a limited number of cases of tularemia. It appears to have shortened the clinical course of the disease.

SUMMARY

An outline of the more important methods in the treatment of conjunctivitis is presented with special emphasis on the value of determining the cause whenever possible. Some of the more important laboratory procedures are summarized, and the mechanism of bacterial infection of the conjunctiva, together with its defensive reactions, is described.

66. Verhoeff, F. H.: Personal communication to the author.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

Postgraduate Course in Ophthalmology.—The tenth special course for postgraduate study in ophthalmology will be given between Oct. 3 and Dec. 7, 1938, under the auspices of the American Medical Association of Vienna at the First and Second Eye Clinics of the Allgemeines Krankenhaus, Vienna, Austria.

The course has been so arranged that the field can be covered systematically and comprehensively in the allotted time. A preliminary knowledge of ophthalmology is presupposed. The entire course is given in English, for a minimum of ten and a maximum of seventeen men. The fee is $260. Further information can be secured by writing to Prof. Dr. A. Fuchs, Vienna, VIII, Skodagasse 13, or to the American Medical Association, Vienna, VIII, Alserstrasse 9, Cafe Edison.

Medical Society of the State of New York, Section on Ophthalmology and Oto-Laryngology.—The program of the Section on Ophthalmology and Oto-Laryngology of the Medical Society of the State of New York, which will be held on Tuesday, May 10, at the Waldorf Astoria, Le Perroquet Suite, is as follows:

Instruction Hour, 9:00-10:00 a. m.: "Tumors of the Eye and Adnexa," by Dr. Georgiana Theobald, Chicago.

"Compensation for Eye Injuries: Its Past, Present and Future in New York State," by Dr. Albert C. Snell, Rochester, N. Y., with discussion by Dr. D. F. Gillette, Syracuse, N. Y.; Dr. Anton S. Schneider, Plattsburg, N. Y., and Dr. Morris Davidson, New York.

"The Treatment of Tumors of the Lids: By Radiation," by Dr. Hayes E. Martin, New York, and "The Treatment of Tumors of the Lids: By Surgery," by Dr. John M. Wheeler, New York, with discussion by Dr. Arthur J. Bedell, Albany, N. Y.; Dr. Walter S. Atkinson, Watertown, N. Y., and Dr. Ralph I. Lloyd, Brooklyn.

International Organization Against Trachoma.—A meeting of the Executive Committee of the International Organization Against Trachoma was held on Dec. 9, 1937, at the Semiramis Hotel, Cairo, Egypt.

The secretary general read the minutes of the last meeting of the Executive Committee, held in Paris in 1936. The accounts were examined and found to be correct. The subvention given for purposes of research by the American Academy of Ophthalmology and Otolaryngology, $100, was allocated to Dr. Poleff of the Pasteur Institute at Rabat, Morocco. It was decided to hold the next meeting of the organization at the same place and at the same time as the next meeting of the International Council of Ophthalmology in 1939.

An assembly of delegates was held on Dec. 10, 1937, at the Semiramis Hotel, Cairo.

A statement was made by the president as to the business to be transacted. The audited accounts were passed. Prof. Manuel Marquez was elected an honorary member of the Executive Committee.

The president, Dr. MacCallan, and the secretary general, Dr. Wibaut, are to remain in office, having been elected for a period of five years at the meeting in London in 1935. According to the statutes, four members of the Executive Committee were due to retire in 1935; however, as all members were due to retire by 1937, it was decided at the 1935 meeting to defer elections until 1937 in order to obtain the presence of the maximum number of delegates.

The president explained that six nations were already represented on the Executive Committe, as follows:

Great Britain, Dr. MacCallan, president
Holland, Dr. Wibaut, secretary general
France, Dr. Bailliart, ex-officio as a representative of the International Association for Prevention of Blindness
United States, Dr. Park Lewis, ex-officio as a representative of the International Association for Prevention of Blindness
Hungary, Professor de Grosz, honorary member
Spain, Professor Marquez, honorary member

There being twelve vacancies on the committee, the president proposed that twelve nations should be represented other than those previously mentioned and that a national representative should be selected by each national group; he also proposed that, as provided in the statutes, no distinction should be made as to vice presidents, members and secretaries. These proposals were accepted.

It was then proposed, seconded and carried that the following nations, being the most trachomatous, should be represented on the Executive Committee: Argentina, Bulgaria, Czechoslovakia, Egypt, Germany, Italy, India, Japan, Lithuania, Poland, Rumania and Turkey.

The meeting was concluded with a vote of thanks to the president.

Subsequently, it was announced that the national groups of the aforenamed countries had selected the following physicians as their representatives:

Argentina, Dr. José A. Séna
Bulgaria, Professor Pascheff
Czechoslovakia, Professor Kadlicky
Egypt, Dr. Tewfik
Germany, Professor Röhrschneider
Italy, Professor Leonardi
India Dr. Mukerjee
Japan, Professor Oguchi
Lithuania, Dr. Avizonis
Poland, Dr. Zachert
Rumania, Professor Michail
Turkey, Dr. Naci Bengisu

German Ophthalmological Society.—The German Ophthalmological Society will meet in Heidelberg, Germany, July 4 to 6, 1938. The principal theme for consideration is the normal and diseased lens, and the subjects will be handled by the following men:

1. Prof. Josef Kampfhamer, Freiberg: "Intermediary Cell Metabolism of the Lens."

2. Prof. Adolf Jess, Leipzig: "The Albumin of the Lens."

3. Prof. H. Süllmann, Basel: "Carbohydrate Metabolism of the Lens."

4. Prof. H. K. Müller, Berlin: "The Genesis of Central Cataract."

5. Docent Dr. Walter Rauh, Leipzig: "Lens and Hormones."

6. Docent Dr. Max Bücklers, Tübingen: "Genesis of Cataract from the Standpoint of Heredity."

7. Prof. Alois Meesmann, Kiel: "The Differential Diagnostic Importance of the Slit Lamp Examination of the Lens."

8. Prof. Wolfgang Stock, Tübingen: "The Operative Removal of the Lens, Including Complicated Cataract and Dislocated Lens."

9. Prof. Heinrich Erggelet, Göttingen: "Optical Correction of the Aphakic Eye."

In addition, there will be two sessions for the reading of papers and a demonstration session.

Tennessee Academy of Ophthalmology and Otolaryngology.—The Tennessee Academy of Ophthalmology and Otolaryngology met in Nashville, Monday, April 11. The officers were Dr. Kate Zerfoss, Nashville, president, and Dr. W. D. Stinson, Memphis, secretary-treasurer. The guest speakers were Dr. Harold Lillie, of the Mayo Clinic, Rochester, Minn., Dr. W. I. Lillie, head of the department of ophthalmology, Temple University, Philadelphia, and Dr. Ernest W. Goodpasture, of the department of medicine, Vanderbilt University, Nashville.

GENERAL NEWS

Postgraduate Course, University of Michigan.—The department of postgraduate medicine of the University of Michigan and the Michigan State Medical Society announce the eighth annual postgraduate course in ophthalmology and otolaryngology at the University Hospital, Ann Arbor, Mich., April 21 to 27, 1938. The first three days of the course will be devoted to otolaryngology, under the direction of Prof. A. C. Furstenberg, and the last three days, to ophthalmology, under the direction of Prof. F. Bruce Fralick.

The fee for the course is $25, or $15 for either division, payable on application. If a registrant is unable to attend, the fee will be returned.

Guest lecturers in ophthalmology will be Dr. John O. McReynolds, Dallas, Texas; Dr. Cecil S. O'Brien, Iowa City, and Dr. Cyrus W. Rutherford, Indianapolis. The resident teaching staff will be Dr. F. Bruce Fralick and Dr. Rollo E. McCotter.

UNIVERSITY NEWS

Dr. Parker Heath has been appointed professor of ophthalmology and director of the department of ophthalmology at the Wayne University Medical School, Detroit.

Dr. F. Bruce Fralick has been appointed professor of ophthalmology and director of the department of ophthalmology at the University of Michigan.

PERSONAL

Dr. George H. Mathewson, of Montreal, Canada, formerly professor of ophthalmology at Bishops College and later clinical professor of ophthalmology at McGill University, died suddenly on March 18. He retired from the Montreal General Hospital in 1931.

Correspondence

VITAMIN D AND MYOPIA

To the Editor:—In my article on "Vitamin D and Myopia" in the January issue of the ARCHIVES (**19:** 47, 1938), I stated that I knew of no experiments to determine the amount of calcium in normal and pathologic scleras. There has now come to my attention an article entitled "Myopia and Calcium Metabolism" by Dr. J. Strebel, appearing in the *Klinische Monatsblätter für Augenheilkunde* (**99:** 325 [Sept.] 1937). Strebel states that he showed in an earlier article that the sclera of the human eye with normal vision contained 3 per cent of calcium. He also reports 4 cases of myopia, in each of which the myopia developed after the twenty-fifth year together with disturbances of the calcium metabolism.

JOSEPH LAVAL, M.D., New York.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Biochemistry

CEVITAMIC ACID IN THE AQUEOUS HUMOR. J. FRANTA, Compt. rend. Soc. de biol. **126:** 110, 1937.

In the rabbit the aqueous contains 20 mg. of reduced vitamin C per hundred cubic centimeters, and the blood, 2 mg. of the oxidized form of vitamin C per hundred cubic centimeters. That the greater vitamin content in the aqueous is due to a hemato-ocular barrier through which the reduced form cannot pass is indicated by several experimental observations. After paracentesis, the titer is lowered for the succeeding week; after enucleation, the vitamin C content of the aqueous becomes reduced by half in seven hours. The aqueous of the rabbit is richer in vitamin C than that of man, which averages about 15 mg. per hundred cubic centimeters; but in human eyes with uveal inflammation the titer diminishes to 3 mg. per hundred cubic centimeters. In children operated on for congenital cataract, the aqueous may attain a normal vitamin C content after several years. Dextrose given intravenously or by mouth to rabbits increases the vitamin C content of the aqueous in from twenty to forty-five minutes. Owing to the difference in diet, the aqueous of the rabbit contains proportionately more vitamin C in summer than in autumn. Hence it is probable that at least part of the vitamin C in the aqueous is derived from the blood.

J. E. LEBENSOHN.

LACRIMAL ELIMINATION OF DEXTROSE IN ALIMENTARY GLYCOSURIA. D. MICHAIL and N. ZOLOG, Compt. rend. Soc. de biol. **126:** 1042 1937.

Eight normal persons with normal conjunctivas were each given 100 Gm. of dextrose to ingest, and determinations of the sugar in the blood and lacrimal fluid were made every thirty minutes thereafter. Lacrimal elimination of dextrose started in thirty minutes and lasted for ninety minutes, the percentage concentration varying from 0.003 to 0.03, values less than in epinephrine glycosuria. In both alimentary and epinephrine glycosuria the lacrimal gland proved more permeable to sugar than the kidney.

J. E. LEBENSOHN.

Conjunctiva

PROLONGED SIMULATION OF "PETRIFYING CONJUNCTIVITIS." J. SÉDAN, Ann. d'ocul. **174:** 672 (Oct.) 1937.

In 1913 Sidler-Huguenin, in terminating his article on petrifying conjunctivitis, said that he thought that this condition should be dropped from the ophthalmic literature as the observations made about it did

not correspond to a definite etiology or to a precise clinical entity but depended on the simulation, as shown by the name.

Sédan reports in detail the case of a girl 19 years of age who during a period of ten months of observation had calcareous secretions, more or less abundant, in the conjunctival sac of one eye. Although the condition did not differ essentially from that in other known cases, a striking feature here was the intensity of the corneal lesions. Also notable was the duration of the lesions, the indisputable pithiatism of the pseudomalady and lastly the "relapse" of the condition during an operation for appendicitis.

The patient was observed by Morax from June 1928, when she first presented herself, until April 1929. At the latter time he was convinced that the lesions were provoked, and later when the patient was admitted to the hospital for an appendectomy this was confirmed by the discovery in her clothing of a small box containing two kinds of powder, one white and the other gray, which served to provoke and continue the conjunctivitis.

S. H. McKee.

A Contribution to the Knowledge of the Importance of Herpes Infections in Corneal and Conjunctival Diseases, Especially in Membranous Conjunctivitis. K. O. Granström, Acta ophth. **15:** 361, 1937.

The author believes that thin fibrinous membranes on the palpebral conjunctiva constitute a feature of severe unilateral conjunctivitis caused by the herpes virus. In some cases swelling of the preauricular node and fever are present, and often either dendritic keratitis or typical herpetic vesicles of the skin of the lids facilitate diagnosis. Superficial punctate keratitis and disciform keratitis also occur. Transmission of material to the eye of a rabbit will produce typical herpetic keratoconjunctivitis, whereas the usual bacteriologic examinations give negative results. Six cases are reported.

O. P. Perkins.

Congenital Anomalies

Congenital Vascular Veils in the Vitreous. I. Mann and A. Macrae, Brit. J. Ophth. **22:** 1 (Jan.) 1938.

Macrae observed 3 cases of congenital vascular veils in the vitreous in the course of routine examination for refraction. The patients were males aged 17, 20 and 21, respectively. Two were brothers. In all there was a relative amblyopia, 6/12 being the maximum corrected visual acuity. The authors give a detailed description of the fundus in all 6 eyes.

In general terms, the condition may be described as a thin transparent veil lying well forward in the vitreous. The transparency of the veil and the fact that the retina can be seen in position through it show that the veil is not formed of a double fold of the retina but is an additional structure lying in front of it. In some instances there were vessels in the veils. In one part of their course they were retinal in

origin and in another part they were from the vitreous. In 2 eyes there were choroidal changes in the periphery, and in 1 eye there was a shallow detachment.

The authors discuss fully the etiologic possibilities of this condition. They state that it seems probable that the veil is in the nature of a condensation of vitreous and that in its commencement it was in contact with the inner layer of the optic cup. It may be similar to the vascular condensation of vitreous sometimes seen in cases of congenital retinal fold. The authors favor the view that the vessels in the veil may be retinal vessels which have secondarily grown into the vitreous condensation, where it is abnormally adherent to the retina.

The article is illustrated.

W. ZENTMAYER.

Cornea and Sclera

TREATMENT OF HERPETIC KERATITIS WITH VITAMIN B. J. NITZULESCU and E. TRIANDAF, Brit. J. Ophth. **21:** 654 (Dec.) 1937.

Two cases of herpetic keratitis are reported in which vitamin B was administered.

The first case was that of à 16 year old boy. The initial condition was gonorrheal conjunctivitis. After the conjunctival secretion had disappeared, vesicles appeared on each cornea. Usual methods of treatment failed to relieve the intolerable pain. Injections of vitamin B_1 were given, and in ten days the corneal lesions had cleared except for a single area of infiltration.

The second case was that of a woman aged 33. In the right eye there was a corneal nebula resulting from an inflammatory condition at the age of 3. In the left eye there was herpetic keratitis. The condition rapidly improved under local treatment and the injection of Vitamin B_1.

While 2 cases are insufficient on which to base definite conclusions, the authors believe that the result of the treatment was more than a coincidence, and they are encouraged to propose vitamin B_1 therapy in cases of herpetic keratitis and generally in cases of all painful and neurogenic conditions of the cornea.

W. ZENTMAYER.

ETIOLOGY OF KERATOCONUS. E. DE SANCTIS, Ann. di ottal. e clin. ocul. **65:** 279 (April) 1937.

The physical findings and the results of roentgenographic examination of the skull in five cases of keratoconus were recorded. In no case was any information obtained which seemed of significance in regard to the etiology. One patient was a mongolian idiot with bilateral cataract. No evidence was found of endocrine imbalance. In three cases the sella turcica was larger than normal, although no signs of pituitary insufficiency were present. The author believes that it is possible that abnormalities of the hypophysis may have been responsible for the increase in the size of the sella turcica and also for the keratoconus without having produced any clinical signs of glandular imbalance.

S. R. GIFFORD.

HEMATIC INFILTRATION OF THE CORNEA. C. S. DAMEL, Arch. de oftal. de Buenos Aires **12:** 18 (Jan.) 1937.

In connection with a case of traumatic infiltration of the cornea, with the production of a permanent corneal opacity and visual reduction to perception of light, Damel reproduces a lengthy and interesting medico-legal report to the courts of justice of Buenos Aires, in which he details and calculates the amount of the resulting damage and visible incapacity in accordance with modern standards.

C. E. FINLAY.

Experimental Pathology

INFLUENCE OF VITAMIN C ON RESISTANCE TO EXPERIMENTAL CONJUNCTIVAL DIPHTHERIA. H. BOCK and G. GROSZMANN, Monatschr. f. Kinderh. **65:** 35 (Jan.) 1936.

It is well known that various persons differ in their resistance to specific infections. The authors' interest was centered on the effect on the resistance of guinea-pigs to induced conjunctival diphtheria of vitamin C added to their regular diet. The literature on previous attempts of this nature is reviewed. The guinea-pigs were sorted into six groups. Group 1 had a diet free from vitamin C. Group 2 had a normal diet. Groups 3, 4 and 5 had a normal diet with 10, 30 and 50 mg. of vitamin C, respectively, added to the diet each day. Group 6 had the normal diet with 175 mg. of vitamin C added daily during the first six days and then 75 mg. In each animal on the twentieth day of the diet the conjunctiva of the lower lid of one eye was cocainized and seared with a glowing spatula and the conjunctiva of both eyes was then swabbed with viable cultures of diphtheria. The diet was continued. All of the scorbutic guinea-pigs were dead in sixteen days. All the guinea-pigs in the other five groups lived. The following tabulation demonstrates the types of infection noted:

	Incidence in Group					
	1	2	3	4	5	6
Observation	Scorbutic Diet	Normal Diet	Normal Diet + 10 Mg. Vitamin C	Normal Diet + 30 Mg. Vitamin C	Normal Diet + 50 Mg. Vitamin C	Normal Diet + 175 Mg. Vitamin C
No lesion	0 (0%)	6 (27%)	13 (59%)	14 (64%)	9 (41%)	14 (64%)
Keratoconjunctivitis	0 (0%)	10 (46%)	9 (41%)	3 (14%)	2 (18%)	7 (32%)
Ulcer of cornea	8 (36%)	0 (0%)	0 (0%)	4 (18%)	2 (9%)	0 (0%)
Panophthalmitis	14 (64%)	6 (27%)	0 (0%)	1 (4%)	7 (32%)	1 (4%)
Total	22 (100%)	22 (100%)	22 (100%)	22 (100%)	22 (100%)	22 (100%)

The authors conclude that animals on a normal diet to which from 10 to 30 mg. of vitamin C is added daily are more resistant to experimental diphtherial conjunctivitis.

L. L. MAYER.

General

ASSOCIATED SYMPTOMS IN OPHTHALMOLOGY. P. WEINSTEIN, Ann. d'ocul. **174:** 679 (Oct.) 1937.

Diagnostic errors occur not only from misinterpreting characteristic symptoms but from not recognizing secondary groups of symptoms

similar to the dominant ones. Thanks to the development and perfection of instruments, one is able more and more to diagnose such conditions and to treat both of them at the same time, assuring complete recovery.

Observations on the following combinations of diseases are detailed: tabes and nicotine-alcoholic neuritis, tabes and syringomyelitis, simple glaucoma and suprasellar calcification, embolus of the cuneus and sellar calcification, thrombosis of the central vein of the retina with intraocular tumor and absolute glaucoma and chronic inflammatory glaucoma and cerebral arteriosclerosis.

These associations confirm the connection that exists between ophthalmology and other branches of medicine, which the practitioner may ignore.

S. H. McKee.

General Diseases

Dermatological Aspect of Affections of the Eye. G. B. Dowling, Brit. M. J. **2**: 794 (Oct. 23) 1937.

The author, a dermatologist, devotes much space to a consideration of rosacea. Slight digestive disturbances are frequently regarded as the cause, but in at least one half of the cases no symptoms of these disturbances were elicited. The author was impressed with the frequency of a life-long vasomotor disturbance. The causes seem to be faulty diet and hygiene. A case is cited in which a patient improved remarkably on a strict diabetic diet. One investigator found a low hydrochloric acid content in 48 per cent of the cases studied. Excessive drinking of tea is often an important factor; the menopause, during which vasomotor disturbances may be accentuated, is also a principal cause. In the consideration of blepharitis, it is important to draw a sharp line of distinction between seborrhea and dandruff. Dowling divides cases of dermatitis of the eyelids into four groups: (1) those of infective dermatitis, (2) those in which the condition is due to irritation by chemical substances, (3) cases of seborrheic dermatitis and (4) cases in which there was no known cause for the dermatitis. The last group is, unfortunately, the largest. Local treatment is difficult. Under a miscellaneous classification, lupus vulgaris, lupus erythematosus, basal cell epithelioma, pemphigus, warts and xanthelasma are described. Xanthelasma is best treated by a minor operation, such as one described by Kromayer in which the tumor is easily shelled out under local anesthesia. Some dermatologists treat this condition with trichloroacetic acid.

Arnold Knapp.

Arachnodactylia. J. Malbrán and H. R. Pícoli, Arch. de oftal. de Buenos Aires **12**: 3 (Jan.) 1937.

After a detailed review of the literature on the symptomatology of arachnodactylia and the influence of heredity since this disease was first described by Marfan in 1896 as "dolichostenomelia" and a full discussion of the different theories concerning etiology, the authors report a series of cases in 2 families.

In the first family a father and 3 children were affected. (Two other children were not examined but were reported to have sound

eyes.) The father did not have any osseous lesions, and ocular examination revealed atrophy of the iris, subluxation of the lens, detachment of the retina and atrophy of the optic nerve in one eye and subluxation of the lens in the other eye. The mother was healthy. A boy aged 14 years had irregular development of the feet and cardiac lesions (pulmonary sclerosis). The right eye showed subluxation of the lens upward and choroidal lesions, and the left eye, subluxation of the lens. A girl aged 10 years had flat feet, elongated toes and fingers and aortitis. There was subluxation of the lens in each eye. A girl aged 6 years had dolichocephalic hands, arachnodactylia, lordosis, aortic sclerosis and dilatation of the heart. Examination of her eyes showed miosis and luxation of the lens upward; the fundi were normal.

In the second family the mother and 3 daughters (of 7) were examined. The mother had syphilitic iritis, was tall and presented lordosis, marked development of the hands and feet (her father was also large) and elongation of the fingers and toes, which were not deformed. Examination of her eyes showed deposits of pigment on the posterior surface of the cornea and the anterior lens capsule and no luxation of the lens. Of the 3 daughters, only 1 showed signs of the disease. She was aged 12 years, was retarded in development and had Hutchinson teeth, a broad nose, rhagades and a high palate. She was above normal in stature; the long bones were markedly developed, and the hands showed indications of arachnodactylia. She had lordosis and flat feet. The right eye showed microphthalmia, with microcornea and luxation of the lens upward. The lens was opaque, with broad synechia at the inferior pole, vascular penetration and no vision. The left eye showed microphthalmia and microcornea. The cornea was transparent, the lens normal and the vitreous clear. Doyne's choroiditis was present at the posterior pole of the eye, and there were peripheral pigmentary changes. Vision with correction of the refractive error (myopia) was 1.

C. E. FINLAY.

Glaucoma

POTASSIUM-CALCIUM INDEX AND EPINEPHRINE CONTENT IN THE BLOOD IN CASES OF GLAUCOMA. E. TRON and A. ODNASHEVA, Vestnik oftal. **11**: 1, 1937.

A review of the literature is given on two antagonistic views concerning the influence of the sympathetic nervous system in cases of glaucoma: its depressive and its irritative action. With a number of biochemical tests, Passow found an increase in the iodine content of the blood of glaucomatous patients or thyrotoxicosis and an increase in the tonus of the sympathetic nervous system due to a low potassium-calcium index. He also found an increase in the epinephrine content of the blood, which indicates a hyperfunction of the chromaffin system of the adrenal glands.

Because of the controversial opinions and in order to verify Passow's findings, Tron and Odnasheva attempted to determine the potassium-calcium index of the blood as one of the signs of the tonicity of the vegetative nervous system. The potassium content of the blood was

determined by the Kramer-Tisdall method and the calcium content by the De-Vaard method. Twenty-five patients with simple and inflammatory glaucoma and 20 control patients were examined. The results of the tests are presented in three tables.

Tron and Odnasheva also used the Kravkov method (on an isolated rabbit's ear) to determine the epinephrine content of the blood serum of 14 patients suffering from primary glaucoma and of 14 control patients. The test, which is described in detail, shows chiefly the vasoconstrictor action of normal serum and that of the serum of glaucomatous patients. The results were as follows:

1. The calcium content in the serum of 25 glaucomatous and 20 control patients was about equal, the values being 10.28 and 10.38 mg. per hundred cubic centimeters, respectively.

2. The potassium content was higher in the serum of the glaucomatous patients than in the serum of normal patients. The average for the first group was 25.48 mg. per hundred cubic centimeters; for the second group, 22.12 mg. The potassium-calcium index of the blood serum for patients with glaucoma was 2.45 and for the control patients, 2.14; this slight difference is not reliable, so that no preference can be given in favor either of sympathicotonicity or of vagotonicity.

3. The determination of the content of vasoconstrictor material in the serum of glaucomatous patients after Kravkov's method (on an isolated rabbit's ear) showed an increase of epinephrine in 11 of 14 patients. This factor, i. e., the influence of the adrenal glands on the pathogenesis of glaucoma, can be evaluated only after a determination of the frequency of glaucoma in association with general diseases which are accompanied by an increase in the epinephrine content of the blood serum.

O. SITCHEVSKA.

GLAUCOMA-LIKE CUPPING OF THE OPTIC DISK AND ITS ETIOLOGY. E. D. NIELSEN, Acta ophth. **15:** 151, 1937.

This article deals with cases in which glaucoma-like cupping of the optic nerve is present and in which increased intra-ocular tension either is not demonstrable or is demonstrable only with difficulty. There is a brief historical survey, followed by a presentation of 12 cases studied by the author.

Examinations of the visual fields, plottings of twenty-four hours' tension, water tolerance tests and roentgenographic examinations were performed in these cases and served to establish the diagnosis of glaucoma in 5. In 3 other cases glaucoma was thought to be complicated by changes in the optic nerve of traumatic or arteriosclerotic origin. In 2 cases the cupping was held to be due to pressure atrophy, the result of a tumor of the brain and in 1 case it was probably due to a congenital malformation. In another case it proved impossible to find any natural explanation for the cupping.

The author emphasizes the diagnostic value of perimetry and feels that the water tolerance test is also a great aid, more so than tonometry over a twenty-four hour period.

O. P. PERKINS.

Instruments

ASPIRATING CUP FOR EXTRACTION OF CATARACT. J. LIJÓ PAVÍA, Arch. de oftal. de Buenos Aires **12:** 147 (March) 1937.

A third model of an aspirating cup, attached to an aspirating syringe, is described. As in the other models, the vacuum is produced by drawing out the piston, a catch preventing its going back, and the vacuum is communicated to the cup by pressing a button. This model differs from the other models, which have an aspirating power of only 35 Gm., and from Arruga's model, which has an aspirating power of 50 Gm., in that the degree of aspiration produced reaches 100 Gm.

C. E. FINLAY.

Lacrimal Apparatus

DIVERTICULUM OF THE UPPER LACRIMAL CANALICULUS IN THE HUMAN FETUS. O. BARATTA, Ann. di ottal. e clin. ocul. **65:** 446 (June) 1937.

Baratta sectioned a 100 mm. embryo and found a diverticulum opening into the upper canaliculus at an acute angle. It passed into the upper lid external to the canaliculus and was patent in its proximal two thirds. He examined a number of fetuses ranging from 100 to 250 mm. in length and found evidence that such diverticula in a rudimentary form are not so rare as has been supposed, although in most cases the epithelial columns representing such rudiments may never become patent. Clinical cases in which diverticula developed in later life are reviewed.

S. R. GIFFORD.

Lens

OPACITIES OF THE LENS IN CASES OF PSORIASIS. E. TROVATI, Ann. di ottal. e clin. ocul. **65:** 256 (April) 1937.

The literature on cataracta neurodermatica is reviewed. Trovati examined all patients with psoriasis in the dermatologic clinic at Genoa with especial reference to opacities of the lens. Of fifty patients, six showed changes in the lens, which in some instances were detectable only with the slit lamp. Examination of patients with other cutaneous conditions, including twenty with chronic eczema and eight with scleroderma, did not reveal any opacities which could be considered to form a true cataract. The opacities in the patients with psoriasis had not produced marked loss of vision, which was still normal in most instances. A slowly progressive increase in the opacities was noted in these patients. The opacities affected the deeper layers of the anterior cortex, the subcapsular layers being transparent. A few opacities were seen in the posterior cortex. They were chiefly in the periphery of the lens, with a radial distribution. General examination, including studies of glandular function and of blood chemistry, revealed no significant abnormalities. The ages of the patients varied from 21 to 37.

S. R. GIFFORD.

THE ISO-ELECTRIC POINT OF THE CRYSTALLINE LENS IN EXPERIMENTAL PARATHYROPRIVAL CATARACT. T. MAESTRO, Ann. di ottal. e clin. ocul. **65:** 453 (June) 1937.

By the precipitation method, Maestro studied the iso-electric point of the lenses of parathyroidectomized rabbits, including cataractous lenses and those which remained clear. Both lenses of 4 animals were examined after thyroidectomy, while one lens was removed from each of 4 other animals and used as a control before operation. Four normal animals were used as controls.

The normal iso-electric point was found to be approximately p_H 5, and no second iso-electric point was found. In parathyroidectomized animals a slight but constant lowering of the iso-electric point, to about p_H 4.8, was noted. The same change was found both in clear lenses and in those presenting opacities. There is, hence, no experimental evidence that a change in the iso-electric point nearer to neutrality occurs after parathyroidectomy which could be assumed as a cause of the opacities of the lens.

S. R. GIFFORD.

VISUAL ACUITY AFTER BILATERAL OPERATION FOR CATARACT IN EARLY CHILDHOOD. W. KISS, Klin. Monatsbl. f. Augenh. **98:** 523 (April) 1937.

Kiss reports on the results obtained by bilateral operation for cataract in early childhood at the University Eye Clinic of Innsbruck. Of 23 children operated on during the first six years of life, 21 could be traced, but the results obtained on 1 were omitted from the report because the child had not completed the third year of life. Linear extraction or discission was done as indicated in each case. Several operations were required in some cases, such as discission, iridectomy and abscission of prolapses. It was found that iridectomy and abscission of prolapses led to severe complications during the first year of life. This was due to especial vulnerability of the iris at this age, as pointed out by Elschnig. Discission sufficed in patients with membranous, or greatly shrunken, cataracts. Congenital total cataract was operated on during the first year of life, if possible. Of the 38 eyes operated on, 6 became blind, 3 after secondary operations were done elsewhere. Kiss compares his results with those obtained at other ophthalmic hospitals and arrives at the following conclusions: Hardly one half of the children who are born practically blind acquire sufficient vision on operation to attend school or to engage in an occupation. All of the children, on the other hand, who possess a certain amount of vision prior to the operation obtain sufficient vision. The unfavorable results in the first group are due to complications encountered during or after the operation. They are brought on in consequence of the peculiarity and poverty of the country, which render proper postoperative care impossible.

K. L. STOLL.

Lids

THE TREATMENT OF SEBORRHEIC BLEPHAROCONJUNCTIVITIS. W. B. CLARK, Am. J. Ophth. **20:** 808 (Aug.) 1937.

Clark draws the following conclusions concerning the treatment of seborrheic blepharoconjunctivitis:

"1. Seborrheic blepharoconjunctivitis is a more prevalent problem than the ophthalmological literature indicates.

"2. It is amenable to treatment that can be administered by any eye physician without the use of expensive additional equipment.

"3. The treatment must be carried out over a long period of time. Recurrences are to be expected, but persistence and patience in treating this condition will be rewarded."

W. S. REESE.

MIMICAL ECTROPION OR ENTROPION OF THE EYELIDS: MONOLATERAL AND BILATERAL. S. HOLTH, Acta ophth. **15:** 370, 1937.

This curious item deals with the unique accomplishments of 2 brothers. One of them, after a series of facial gymnastics, is able completely to evert one or both upper eyelids. The other can roll in one or both lower lids.

Photographs show some of the contortions, together with the end results.

O. P. PERKINS.

Neurology

UNILATERAL HEREDITARY AND CONGENITAL IRRITATION OF THE CERVICAL PORTION OF THE SYMPATHETIC TRUNK: REPORT OF A CASE. P. M. GEORGARIOU, Klin. Monatsbl. f. Augenh. **98:** 306 (March) 1937.

Georgariou introduces his paper with remarks on the importance of the sympathetic trunk, especially its cervical portion, to the ophthalmologist. He adduces the literature in point, mentioning that in most of the reports a disturbance of this part of the nervous system was considered a secondary complex. His case of chronic hereditary congenital irritation of the cervical portion of the sympathetic trunk differs in this respect, as the disturbance was primary. It is the first case of this kind to be reported since that published by Michel in 1903, which is the only other case in this category. Michel's patient was a 9 year old boy.

Georgariou's patient, a young woman, and some other members of her family had had a large palpebral fissure in one eye since birth. The large fissure in the young woman was in the left eye. The left upper lid was 3 mm. higher than the right, and a slight spastic strain was evident when she attempted to close the eye; the lid did not follow the eye when she looked down. The pupils were equal and reacted normally. Coppez's test with epinephrine and cocaine gave a normal reaction. The extrinsic muscles of the eye were undisturbed, and lagophthalmos was absent. Vision was normal in each eye, and no ocular symptoms were found, except slight narrowing of the retinal vessels

in the right eye. No secretory anomalies, such as a disturbance of perspiration, existed, and the Wassermann and Mantoux tests were negative. Georgariou discusses whether an irritation of this type is due to a direct or an indirect cause, whether pressure of the thyroid gland on the sympathetic trunk may produce the irritation, whether endocrine disturbances may be instrumental or whether an infection due to a neuropathic virus may be the cause in some cases. Georgariou does not agree with Michel's opinion as to a neuropathic hereditary etiology. He considers the elevation of the lid and its limited concomitant motion on downward gaze to be the result of a slight congenital anomaly of the tissues or vessels, which causes a chronic irritation at a certain point in the cervical portion of the sympathetic trunk. Hitherto unknown laws of heredity transmit this anomaly from generation to generation.

K. L. STOLL.

Ocular Muscles

DIVERGENT STRABISMUS. E. E. CASS, Brit. J. Ophth. **21:** 538 (Oct.) 1937.

Cass reviews the various conditions which have been assigned as causes of divergent strabismus and gives an analysis of eighty-eight cases of this condition. The article should be read in the original, as the statistical features do not lend themselves to abstraction.

W. ZENTMAYER.

TREATMENT OF CONCOMITANT SQUINT BY ORTHOPTIC METHODS. G. G. PENMAN, Brit. M. J. **2:** 1019 (Nov. 20) 1937.

In determining which patients with concomitant squint are suitable for treatment by orthoptic methods, Penman considers age, intelligence and psychologic state, refraction, vision and retinal correspondence. The average period of attendance for each patient in the "squint department" at the Royal Westminister Ophthalmic Hospital is forty-eight days. After treatment is completed, the patient is seen at intervals of from one to three or more months.

As a result of his experience, Penman prefers to operate on persons between the ages of 12 to 14, because local anesthesia can be used and necessary adjustment of the eyes can be better determined. Also, there is a possibility of the squint's straightening of its own accord if one does not operate sooner. There are other factors, such as the psychologic state, circumstantial elements, the amount of squint and the results of orthoptic training, which allow operation at an earlier age.

The patients who do best with orthoptic treatment are those with squint of a slight degree, especially of the accommodative type. For the others, treatment combined with operation offers a physiologic cure except when there is persistent amblyopia, false projection or complete lack of fusion sense.

In conclusion, Penman states that at the Royal Westminister Ophthalmic Hospital nearly half of the patients with concomitant squint have had to have an operation. At the same time the standard of the results of treatment is now much higher than in the old days when the

cosmetic appearance was the only criterion. In the author's opinion, there is no doubt that operation is needed less often than formerly, that the operative results are better and more permanent and that a second operation may be avoided if orthoptic treatment is followed. In brief, orthoptic treatment is a valuable adjunct and makes for a much higher percentage of real successes.

ARNOLD KNAPP.

Physiology

INFLUENCE OF THE ADMINISTRATION OF WATER ON THE ARTERIAL BLOOD PRESSURE AND ON INTRA-OCULAR PRESSURE: CLINICAL AND EXPERIMENTAL RESEARCH. V. SPADAVECCHIA, Ann. di ottal. e clin. ocul. **64:** 611 (Sept.); 697 (Oct.) 1936; **65:** 194 (March) 1937.

Spadavecchia reviews the status of the problem of the relation between arterial blood pressure and intra-ocular pressure. A study is made of the changes in systolic and diastolic blood pressure that take place for twelve hours after the ingestion of 1,500 cc. of water given from 8 to 8:30 in the morning after a fast of twelve hours. The changes in arterial pressure with respect to the original blood pressure, the cardiac and renal status and the role played by the anatomic and functional status of the arteries in producing these changes during the test are analyzed.

After making a study of the influence of body position on intra-ocular pressure in normal eyes, Spadavecchia proceeds to consider the changes in intra-ocular pressure produced in 29 patients (56 eyes) during the foregoing tests. The eyes were a mixed group, i. e., normal and glaucomatous eyes with normal and pathologic capillary beds. The author concludes that the intra-ocular pressure depends on the condition of the arterial bed of the eye and that there is a limit of separation between general arterial pressure and intra-ocular pressure. This he calls the "endocular threshold," or the "threshold of intra-ocular pressure." Its high physiologic level may be altered by various morbid and premorbid local conditions, especially those associated with the arterial system.

F. P. GUIDA.

THE VALUE OF MUSCULAR WORK IN THE REGULATION OF THE INTRA-OCULAR TENSION. V. P. FILATOV, Vestnik oftal. **11:** 151, 1937.

Filatov presumes that the intra-ocular tension is higher in the morning than in the evening because substances of fatigue are lacking in the blood after the muscles have a night's rest. Clinical and experimental observations were made in order to verify this hypothesis.

A patient who suffered from frequent attacks of absolute glaucoma in one eye and chronic inflammatory glaucoma in the other eye, with high tension which did not respond to the use of myotics, was ordered to walk and climb stairs from one to two hours every morning on awakening. Two weeks later the glaucomatous attacks ceased and the tension was lowered, so that it was possible to do a trephine operation

with good results. This patient and two others with similar symptoms were observed for a period of about eighteen months.

In dogs and rabbits which were made to race, the intra-ocular tension was lowered after racing. Further study on this subject is being done at the Odessa Eye Clinic and the Experimental Institute in Kiev. The following conclusions were arrived at:

1. Muscular work aids the regulation of tension in cases of glaucoma.

2. In human beings physical exercises cause an increase of the blood pressure and a decrease of the intra-ocular tension.

3. The intra-ocular tension is lowered in animals fatigued from racing.

4. The blood of such animals acquires the quality of lowering the intra-ocular tension of control animals when introduced into their blood.

O. SITCHEVSKA.

Refraction and Accommodation

THE AVOIDANCE OF DYNAMIC ACCOMMODATION THROUGH THE USE OF A BRIGHTNESS-CONTRAST THRESHOLD. M. LUCKIESH and F. K. Moss, Am. J. Ophth. **20:** 469 (May) 1937.

Luckiesh and Moss give the following summary:

"The sensitometric method possesses the following indicated characteristics: dynamic accommodation is controllable without the use of drugs and without inhibiting tonic accommodation; and the significance of subjective refraction is enhanced due to the precision and reliability of the subjective data obtainable. Obviously much additional clinical research is necessary to evaluate the clinical significance of these conclusions. The major purpose of this discussion is to suggest such researches."

W. S. REESE.

HOW AND WHY IT IS POSSIBLE TO CORRECT AND MEASURE HYPEROPIA WITH A SPHEROCONCAVE MIRROR. G. GALLERANI, Ann. di ottal. e clin. ocul. **64:** 801 (Dec.) 1936.

By placing a lens with an inner base curve of + 5.00 D. at a distance of 8 mm. in front of the cornea of an eye with 6.00 D. of hyperopia, it was found that objects at a great distance behind the patient were reflected by the inner surface of the lens so as to be seen distinctly by the patient. Varying the distance from the cornea of a concave mirror of the same curvature resulted in correction of different degrees of hyperopia. Mirrors of other curvatures could be used to correct other hyperopic errors by placing them at the original distance of 8 mm.

The remainder of the paper does not lend itself to abstracting, as it is a diagrammatic analysis of the optics concerned.

The author feels that a mechanism incorporating such a mirror could be designed for estimating refractive errors.

F. P. GUIDA.

Retina and Optic Nerve

RETINITIS OF PREGNANCY. J. N. DUGGAN and V. K. CHITNIS, Brit. J. Ophth. **21:** 585 (Nov.) 1937.

The authors report 3 cases of retinitis of pregnancy. In the first case the retinitis was of the characteristic form; in the second case it was of the type associated with the toxemia of pregnancy which is complicated by chronic nephritis, and in the third case the retinitis resembled that in the first case in some respects, yet its nature remained obscure.

The authors conclude that there is only one type of retinitis which can be called the retinitis of pregnancy, that described by Semple and characterized by sudden onset, edema of the retinal tissues, equally sudden cessation on removal of the cause and complete restoration of vision.

Whenever chronic nephritis complicates pregnancy, the visual disturbances are due to renal retinitis. This type of retinitis is associated with high blood pressure, which, together with the signs of retinitis, have a tendency to persist after delivery. This form of retinitis serves as a useful guide in differentiating chronic nephritis complicating pregnancy from preeclamptic toxemia. It should really be classed with the retinitis which is associated with hypertension and chronic nephritis preceding pregnancy.

Apart from their differentiating value, the lesions of the retina are of aid in estimating the damage done to the vascular tree.

In the presence of beginning retinitis, the ophthalmologist should not hesitate to advise interruption of the pregnancy.

W. ZENTMAYER.

THE ANATOMY OF THE CROSSINGS OF RETINAL VESSELS. L. SALLMANN, Arch. f. Ophth. **137:** 619 (Oct.) 1937.

The author has made systematic anatomic studies of the crossings of retinal vessels of persons with and without hypertensive vascular disease. The studies were made on the eyes of cadavers removed as shortly after death as possible. The eyes were fixed in formaldehyde and opened by an equatorial section. With the aid of a loupe, several crossings of retinal vessels with the surrounding retina were excised, embedded in paraffin and sectioned serially. The sections were stained with eosin and hematoxylin, with Van Gieson's stain and with Weigert's elastica stain. Altogether, 129 crossings were studied. These were taken from the eyes of 27 persons who had shown no signs of hypertensive cardiovascular disease. The number of persons and their respective ages at the time of death were as follows: between 20 and 40, 9 patients (group 1); between 40 and 60, 8 patients (group 2), and between 60 and 76, 10 patients (group 3). In addition, the eyes of 5 patients who had had essential hypertension (group 4) and of 5 patients who had died from nephrosclerosis (group 5) were studied. No persons were included in groups 1, 2 and 3 in whom the fatal disease might have affected the ocular vessels.

The study of eyes from persons who had been free from hypertensive disease revealed the following facts:

1. At the crossings the artery and the vein always come in direct contact with each other. The extent of the contact varies.

2. At the crossings one commonly sees an exchange of adventitial fibers between the two vessels.

3. At the crossings the vein may lie above (toward the vitreous) or below (toward the choroid) the artery.

4. Even in young persons without vascular disease the vessels (artery and vein) deviate from their normal straight course at the crossings. In dodging the artery the vein may describe a loop into the outer nuclear layer of the retina. Such a behavior of the vessels at the crossings must, therefore, not be considered as a pathologic phenomenon.

5. With increasing age, the artery becomes more rigid and tends to deviate less at the crossings. In addition, the walls for both vessels become thickened at the crossings, and the number and thickness of the adventitial connecting fibers increase.

Sallmann found that the thickening of the walls of the vessels at the crossings was more pronounced in the eyes of persons who had had essential hypertension than in those of persons of the same age who had been free from hypertensive disease. The eyes of persons who had had nephrosclerosis revealed severe hyaline degeneration of the walls of the vessels and narrowing of the lumens. In those from persons who had had hypertension there often was a distinct adventitial sheath which surrounded both vessels and made it impossible for the vein to move away from or to dodge the artery.

The lower degrees of "nicking" of the veins, therefore, are due to an indentation or deformation of the veins caused by a thickening of the arterial wall, whereas the higher degrees are caused by definite sclerotic changes.

P. C. KRONFELD.

Trachoma

STUDIES ON THE INFECTIVITY OF TRACHOMA. R. W. HARRISON and L. A. JULIANELLE, Am. J. Ophth. **20:** 360 (April) 1937.

Harrison and Julianelle give the following conclusions and summary:

"1. In vitro cultivation of the infectious agent of trachoma has been attempted by tissue-culture methods.

"2. Tissue cultures from six different animal species have been employed, under a variety of conditions.

"3. The temperature range during incubation varying from three to eight days has been from 30 to 37.5° C., and the tissue cultures were incubated aerobically and anaerobically.

"4. Elementary or initial bodies have never been found in any of the tissue cultures.

"5. None of the tissue cultures inoculated in monkeys were able to induce experimental trachoma, even though in many cases the materials from which they were derived were of demonstrable infectivity.

"6. The results indicate an inability of the infectious agent of trachoma not only to multiply but even to survive under the stated conditions of tissue culture.

"7. The data suggest that the infectious agent is characterized by a highly organized tissue specialization which renders in vitro cultivation extremely difficult with the knowledge available at the present time."

W. S. REESE.

Tumors

PLEXIFORM NEUROFIBROMATOSIS (VON RECKLINGHAUSEN'S DISEASE) INVOLVING THE CHOROID, CILIARY BODY, AND OTHER STRUCTURES. J. M. WHEELER, Am. J. Ophth. **20:** 368 (April) 1937.

Wheeler reports a case of neurofibromatosis in a 6 year old girl who was first seen by him in 1929 but who was observed by other colleagues from birth. The right eye was blind and buphthalmic, and the skin of the right upper lid was dark. This lid was completely ptosed, with a tumor-like mass covered by conjunctiva hanging down below the margin of the lower lid and causing ectropion of the outer two thirds. The soft parts of the malar and temporal regions of the right side were thickened, and this tissue had a cordlike feel. Investigations revealed neurofibromatous involvement of the right upper lid, zygomatic and temporal regions, lacrimal gland, apex of the orbit, ciliary body, choroid, sclera and optic nerve. Roentgenographic examination pointed to probable involvement of the hypophysis and structures in the middle fossa of the right side of the skull. The chiasm and optic tract were apparently not seriously involved.

W. S. REESE.

Uvea

THE DEVELOPMENT OF THE PIGMENTED RING LINE OF THE IRIS. L. SALLMANN, Arch. f. Ophth. **137:** 510 (Oct.) 1937.

Of twenty-eight cases in which Lindner's operation for fistula of the vitreous had been performed for the relief of acute glaucoma, in ten there developed on the anterior surface of the iris a pigmented ring line similar to the one which Šafář, Guist and Reese had seen after perforating injury in the posterior segment of the eye. After Lindner's operation, acute hypotony sets in; the iris sinks back, its ciliary portion leaning against the ciliary body, while the pupillary portion retains its frontal position. Thus, a picture characteristic of severe hypotony develops. The intra-ocular capillaries are paralyzed, and their permeability is greatly increased. The protein content of the aqueous is very high, and the uvea is greatly edematous. Under these circumstances the formation of ring-shaped folds in the iris is understandable. The pigmentation of these folds is, according to Sallmann, the result of abnormal proliferation of the chromatophores under the influence of the hypotony.

P. C. KRONFELD.

Society Transactions

EDITED BY W. L. BENEDICT

GERMAN OPHTHALMOLOGICAL SOCIETY

Fifty-First Annual Meeting, Heidelberg, July 6-8, 1936

DOCENT DR. M. BÜCKLERS, Tübingen, *Reporter*

TRANSLATED BY PERCY FRIDENBERG, M.D., New York

Demonstration Session

Tuesday, July 7, 1936, 3 p. m.

WOLFGANG RIEHM, M.D., Giessen, *Chairman*

(Continued from Page 315)

MILIARY TURERCULOSIS OF THE EYE. DR. EDUARD WERDENBERG, Davos-Platz.

Among the forms of ocular tuberculosis the clinical picture of which is most definitely established, i. e., the productive forms, one is struck by the frequency of a miliary type—multiple miliary dissemination (*Aussaat*) in the form of a tuberculous vascular disease. It is most frequently noted in the iris and not infrequently in the choroid. In juvenile subjects with miliary tuberculosis of the iris innumerable deposits of protruding tubercles are often found, which in prognostically unfavorable cases have a tendency to conglomeration. In subjects of a more advanced age it is more common to note "bland" tubercles, which are often sunken in the tissue of the iris and have a tendency to heal slowly. This healing depends on, and is associated with, the blood supply. In the choroid, in addition to acute miliary tuberculosis one not infrequently sees fresh miliary and submiliary lesions. In cases of choroiditis disseminata in which the condition has run its course one occasionally sees areas of healed miliary lesions. Choroiditis disseminata is also seen as a sequela of a fresh miliary seeding, so that the condition may be considered to be mostly a hematogenous dissemination, which is often originally a miliary dissemination, with secondary atrophic-cicatricial changes in the tissue.

THE DISEASE SOURCE OF OCULAR TUBERCULOSIS. DR. EDUARD WERDENBERG, Davos-Platz.

Two interesting facts are discussed on the basis of demonstration material: (1) the decidedly marked parallelism between tuberculous lesions of the eye and those of the thorax, definitely expressed (*a*) as a coarse miliary dissemination in the iris and in the lung and (*b*) as a fine miliary dissemination in the choroid and in the lung, and (2) the

presence of an ascending infection from tuberculous hilus glands in cases of ocular tuberculosis. The most important point to note is that mild and severe (roentgenographically) forms of this mediastinal localization may give rise to equally malignant ocular tuberculous lesions. Because of an apparent, but actually nonexistent, antagonism, the ophthalmologist may be led astray by the estimate of the internist, who bases his judgment only on the inadequate roentgenographic aspect. The presence of malignant tuberculous iridocyclitis was demonstrated in a case of tuberculous tumor of the hilus glands and in a case of slight tuberculous involvement of the thorax, as shown roentgenographically. An ascending intrathoracic infection from the hilus glands, with a parasternal roentgenographic shadow, was demonstrated in a case of severe tuberculous iridocyclitis. Simultaneous with the disappearance of the shadow, that is, with the cure of the source of the infection, the iridocyclitis healed. Often a roentgenogram fails to reveal the disease source, and one must infer, in the presence of a malignant intraocular process, that a similarly malignant tuberculous condition is pathogenically active elsewhere.

The Normal and Pathologic Picture of the Interior Apparatus of the Epithelial Cell. Prof. Wilhelm Grüter, Marburg.

A number of pictures and original photomicrographs of Golgi's reticular apparatus, both normal and pathologic were shown, beginning with a picture of the normal corneal epithelium after staining with osmic acid by the method of Kopsch-Kolatschew and Nassonow. In the netlike three-dimensional apparatus the deeply stained black centrosomes stand out conspicuously in the end zone of the nuclear poles. In other pictures are demonstrated the inflammatory reaction of this delicate intercellular network to (1) diphtheria toxin, (2) staphylococcus toxin, (3) oil of mustard and (4) herpes virus. The reaction is apparent in the form of a swelling (*Blaehung*) and progressive densification of the Golgi apparatus, which surrounds the nuclear zone like a wreath, and by inflammatory swelling and division of the centrosomes. What is particularly striking is the marked cell division of the spherical Golgi structures about both poles of the nuclei, large caps (*Hauben*) composed of many individual spheres being formed. In them one notes the Golgi bodies, conspicuous because of the intense black stain, which have increased greatly in number or are in the process of cell division. The same deep stain shows clearly that the Golgi framework in the region of the peripheral cytoplasm has formed many new foci and divisions in the three-dimensional framework zone, with similar changes in the included Golgi corpuscles.

Reimplantation of the Superior Oblique Muscle to Serve as an Adductor Muscle. Prof. W. Wegner, Freiburg.

In 2 children with unilateral oculomotor paresis the cosmetic correction of the position of the eye was attempted by combining tenotomy of the abducens muscle with advancement and displacement of the superior oblique muscle and its attachment to the insertion of the internal rectus muscle. The procedure was carried out through the upper lid. The tendon of the superior oblique muscle was separated from its

insertion, lifted out of the trochlea and carried through Tenon's capsule; the muscle belly was sewed to the insertion of the internal rectus muscle. A satisfactory cosmetic result was attained, with the possibility of a certain amount of inward rotation.

USE OF BUCCAL MUCOUS MEMBRANE IN THE TOTI OPERATION. DR. GERHARD JANCKE, Giessen.

This procedure is recommended when mucous membrane of the nasal or lacrimal sac is lacking, when the sac is markedly shrunken or when further surgical intervention becomes necessary on account of a relapse following the original Toti operation. Up to the present time healing has occurred in two cases in which operation was performed.

CONTRIBUTION TO THE TEACHING OF OPHTHALMOLOGY. PROF. E. SEIDEL, Jena.

Motion pictures were presented demonstrating the steps of extracapsular extraction of cataract without iridectomy.

OCULOMOTOR DISTURBANCES. DOZENT DR. KARL VELLHAGEN, JUN., Halle.

A miniature film was presented showing an informal collection of the most varied disturbances of ocular motility. Among others, the following conditions were shown: exophoria, esophoria, fixation movements, paralysis of the rectus muscles, primary and secondary angular strabismus, forced positions, ptosis, a pseudo Graefe sign, facial paralysis, Bell's phenomenon, fixation paralysis, hysterical blepharospasm, nystagmus associated with amblyopia and amaurosis and good and bad mobility of artificial eyes. Visual disturbances and their correct and incorrect neutralization are to be shown in a forthcoming film.

TREATMENT OF THE EYE WITH ULTRAVIOLET RAYS. W. GUTSCH, Berlin.

Two hundred and seventy-six patients with ocular disease were treated with the ultraviolet rays in the course of a year. No results were noted in cases of corneal disease, but the good effects were unmistakable in cases of chronic iridocyclitis of the sluggish, progressive postoperative form, in cases of chronic iridocyclitis in which the cause was obscure and particularly in cases of tuberculous iridocyclitis. The precipitates decreased, the opacities of the vitreous cleared and the eye became free from irritation. Healing occurred in a short time in several cases of conglomerate tubercle nodules of the iris and of choroidal tuberculosis, so that one is inclined to believe that the ultraviolet rays have a specific action on inflammatory tuberculous processes in the eye. Retinal hemorrhages are absorbed rapidly without leaving any disturbance of retinal function in their wake. During the flooding of the eye with these rays, the retinal vessels become dilated. In 80 cases of retinal and choroidal disease treatment with the ultraviolet rays brought about rapid healing of fresh inflammatory foci and subjective and objective improvement in retinal function impaired by chronic degenera-

tive processes. Surprisingly rapid recession of purulent inflammation of the orbit and of the lacrimal sac was also noted. The treatment was without effect in cases of glaucoma or of scleral disease, but good results were obtained in cases of paralysis of the external ocular muscles and of supraorbital neuralgia. The tube type of apparatus is better than the spark gap apparatus, as the former permits of treatment with a free interspace of air (*Luftabstand*) between the electrodes at a distance from the eyeball of from about 1 to 3 cm.

DISCUSSION

PROF. KARL VOM HOFE, Greifswald: In cases in which as a rule healing occurs without ultraviolet irradiation, one should be careful in using agents of this type, the action of which up to now has not been sufficiently studied experimentally. I wish to call attention to the lesions (*Spätschädigungen*) caused by the roentgen rays, which were not discovered until many years later. Wetzel's studies show that one has to deal with a considerable heating of the vitreous, a reaction which may well account for the dilatation and hyperemia of the retinal vessels observed by the previous speaker.

PROFESSOR ERGGELET, Göttingen: Krause reported early this year at a meeting in Hamburg, on the results obtained at the Göttingen Clinic with the high frequency method of Schliephake. Without wishing to arouse exaggerated hopes, I want to call attention to the excellent and striking results obtained with this treatment in cases of septic thrombophlebitis of the orbit and of phlegmon of the lacrimal sac. The treatment was without effect in cases of sympathetic ophthalmia and of late infection following operation for a cataract.

PROF. W. WEGNER, Freiburg: In not a few cases chronic relapsing iridocyclitis is associated with papillitis. It is my experience that the course in such cases is particularly chronic and not easily influenced therapeutically. I have used short wave therapy in a rather large number of cases, but up to the present time I have not been able to see convincing results. On the other hand, a parapapillary hemorrhage occurred in 1 case. On the basis of this occurrence, I must advise the greatest possible caution in the use of this treatment. Under certain conditions hemorrhage might take place, e. g., in the macular region, which would seriously impair vision. The gist of the procedure is the production of marked hyperemia, which, if it involves an already diseased vascular system, may easily reach a point at which hemorrhages are inevitable.

PROF. M. BAURMANN, Karlsruhe: Professor vom Hofe need not worry about possible damage by the ultraviolet rays analogous to that caused by the roentgen rays, as the effect of the former consists solely in the production of warmth. Any mysterious effects beyond that do not exist. The ultraviolet rays allow one to produce a heat effect on the intraocular tissues such as one often strives for but never obtains with external hot applications and poultices.

PROFESSOR COMBERG, Rostock: Before diathermy or short wave therapy is adopted generally by the practitioner for the treatment of intraocular diseases, preliminary studies are essential to determine what doses can be tolerated by the vitreous without heating it to a dangerous

degree. The vitreous, the lens, the anterior and posterior chamber and the cornea are structures or/and regions in which no blood vessels are present and in which, accordingly, there is no means of diffusing heat as effectively as in other parts of the body. Hence in these tissues there must be a greater degree of heating than in vascular structures after treatment with the ultraviolet rays as well as with diathermy. If the temperature in the vitreous exceeds the degree of toleration, the most serious damage is caused at once. The necessary experimental studies can easily be carried out.

W. GUTSCH, Berlin: In answer to Professor Wegner, the apparatus used up to now at Höchenschwand was not of the tube type used and recommended by me. The biologic effects of this apparatus are quite different from those noted when the *Funkenstreckenapparatus* is used. In answer to Professor Comberg's criticism, so far technical science has not succeeded in constructing an instrument which will enable one to measure accurately and beyond cavil the temperature in a condensation field.

Fourth Scientific Session

Wednesday, July 8, 1936, 8:30 a. m.

DR. BRONS, Dortmund

MEASUREMENTS OF PRESSURE IN THE CENTRAL RETINAL ARTERY IN CASES OF INCREASED INTRACRANIAL TENSION. PROF. M. BAURMANN, Karlsruhe.

One hundred and fifty cases of increased intracranial tension were studied, and the results were tabulated according to age and to pressure in the brain, the retinal arterial tension being expressed in terms of percentage of the corresponding blood pressure in the brachial artery. The figures of a table of averages and the data of a graphic survey of all the individual cases show that there is only an inconstant and loose relation between the two vascular reactions mentioned in the title of the paper. However a similar arrangement of the absolute values for the pressure in the central and the brachial artery in relation to those for intracranial tension shows that the pressure in these arteries rises in sympathy with the intracranial tension. A method was sought to determine the efficiency of the carotid artery, knowledge of which would be of practical value in case ligation of that vessel was contemplated. With manual compression of the carotid artery, pressure in the central retinal artery of the same side falls (diastolic and systolic) at first and then tends to rise and reach the original level. The systolic pressure hardly ever reaches this point, but the diastolic pressure does. On the side opposite the compression there is no fall in pressure but, on the contrary, a rise (in the central retinal artery). This often exceeds that noted simultaneously in the brachial artery (pressor reflex) and may be due in part to a compensatory overaction of the carotid artery, which has remained open. Measurements on 21 subjects ranging in age from 7 to 67 years showed that 4 of 5 older subjects had an extraordinarily marked primary fall in pressure, diastolic as well as systolic, on the side of compression, with hardly any subsequent rise. Compared with youthful subjects, this group also showed a less

marked increase in pressure on the side opposite the compressed carotid artery. The curves are interpreted as the expression of only a slight capacity for compensation on the part of the opposite patent carotid artery. If there is a decided fall on the side of compression in spite of a marked increase in the pressure in the opposite carotid artery, it is fair to conclude that there is a relative narrowness of the circle of Willis. When the final drop in the diastolic pressure exceeds 10 mm. of mercury on the side of compression, the subject would be jeopardized by a ligation of the carotid artery. Ligation of the common carotid artery of a girl aged 18 was followed by hemiplegia. Measurement of the pressure of the central retinal artery after the operation showed that there had been a fall of 18 mm. of mercury in the diastolic pressure on the side of ligation. A moderate rise in pressure was noted three weeks after operation, and in another three weeks the pressure had nearly reached normal. The compression test carried out some time later again showed a fall of 15 mm. of mercury in the diastolic pressure, demonstrating, in accordance with the figures cited previously, that such a marked fall in pressure is a contraindication to ligation of the carotid artery.

Therapeutic Reduction of Intraocular Tension in Cases of Atrophy of the Optic Nerve and of Retinitis Pigmentosa.

Prof. Hans Lauber, Warsaw, Poland.

Professor Baurmann's studies indicate that the diastolic pressure in the retinal veins is equal to the intracranial pressure. Sobański's research in my clinic has developed further the knowledge concerning this relation and has corroborated the foreging conclusion definitely. Hence in many cases it is unnecessary to do a lumbar puncture to determine whether or not there is an increase in intracranial tension. The latter is not the only factor in the pathogenesis of choked disk. The relation between arterial and venous pressure also plays a part. If the blood pressure is high, papilledema does not take place, in spite of a decided increase in intracranial tension, whereas it develops to a slight degree if there is a low systemic arterial blood pressure.

However, this holds good only for the period of pure papillary stasis and not for the stage in which there are secondary inflammatory changes. A pseudopapilledema may be present when the intraocular tension has been lowered or was low from the start, but this condition is seen as a rule only in eyes with hypotony. These problems cannot be decided on the basis of anatomic histologic studies alone. It is essential for one to take into consideration and analyze the retinal circulatory conditions as well. Recent articles like that of Fischer, on pseudopapilledema, which disregard this important factor, are not of a nature to clear up these questions. A clinical study of retinal and systemic blood pressure by my associates and me in a large series of cases has shown that atrophy of the optic nerve develops in cases of tabes when the general blood pressure is lower; or, expressed otherwise, a decided hypotension is present occasionally, sometimes for long periods, in persons with tabes, and it is during these periods that the atrophy appears and progresses. The oculist may be consulted by the patient at a time when his systemic blood pressure is about normal, or even slightly above, but if he is kept under continuous observation for

some time it will be evident that progress of the atrophy in the optic nerve coincides with a fall in the blood pressure. With a return of the blood pressure to normal the atrophic process in the optic nerve comes to a standstill, but it reappears if the pressure falls again. It has been demonstrated that the administration of a number of therapeutic agents, such as arsphenamine, preparations of mercury and of bismuth and iodides, and at times malaria treatment, have a deleterious influence on the blood pressure reducing it and thus causing a catastrophic change for the worse in the process in the optic nerve. This explains the sad fact, fairly well known to all clinicians, that specific treatment of tabes has only an unfavorable influence on the condition of the optic nerve. The atrophy is not directly due to the toxins of the spirochetes, as in that case it would have to appear at a time when the specific organisms are most plentiful in the tissues, viscera and circulation, i. e., when secondary syphilis is present, and not when they have been markedly diminished and when, as is known, the Wassermann reaction of the blood and spinal fluid may have become negative. In this event, there is no protection against the occurrence of atrophy of the optic nerve. In cases of tabes in which there is hypotension, which is often due to a cardiovascular disturbance, such as changes in the walls, dilatation of the aorta or syphilitic myocardial degeneration, atrophy of the optic nerve becomes noticeable and progressive. It is logical to try to raise the blood pressure or, on the other hand, to lower intraocular tension in order to reestablish the normal relations between this factor and the diastolic blood pressure in the retinal vessels. We were able to bring the pathologic process to a standstill and in many cases to ensure considerable and long-continued improvement when we were able to lower the intraocular tension by the use of miotics or, these failing, by operation, generally cyclodialysis, and at the same time to improve the general condition of the patient by the administration of strychnine and of various glandular preparations and the institution of specific treatment. Therapeutic failure was due, generally, to inability to lower the intraocular tension or to the fact that the case with which we were dealing was not one of tabetic atrophy but one of dementia paralytica or of severe vascular disease. Good results like those obtained in cases of tabetic atrophy were obtained in 2 cases of Leber's retrobulbar neuritis of long standing. Both patients, brothers, showed marked lowering of the blood pressure. As there is often a marked disproportion between intraocular tension and diastolic arterial pressure in cases of retinitis pigmentosa, we used the same treatment. Of course, we did not expect to cure the disease itself, the pathogenesis of which is still unknown, but we hoped to improve the circulatory conditions in the retina, as sympathectomy has done according to a number of authors. Up to the present time 21 eyes (12 cases), most of them in far advanced stages of the disease, have been treated. In 14 eyes vision improved, and in more than half of these the visual field, too, became larger. In some cases the improvement has already lasted more than half a year. In 5 eyes the condition has remained unchanged, after improvement for a time in 1 eye. In 2 eyes this temporary improvement was followed by a change for the worse, with recurrence of intraocular hypertension. It is to be expected that the improvement in sight, and in many cases in the visual field, will not be lasting and that the degeneration of the

retina will progress in spite of the temporary improvement in the circulation, as only one pathogenic factor has been affected and the basic cause could not be influenced. Still, even a temporary improvement is in the patient's interest and is worth while. In some of their cases in which sympathectomy was performed also, Caeiro, Malbran and Balza found that improvement after operation was followed by a change for the worse, even after several months. Attempts to improve the retinal circulation by local measures are no novelty. I will not go into the details of the isolated attempts of von Friede (1924), Deutschmann (1924), Gilbert (1924) and Lindner (1936), as the important factor of low blood pressure was not taken into consideration.

I would rather call attention to Abadie's recommendation of retrobulbar injections of atropine for the purpose of dilating the retinal vessels, although it was not shown positively that this was accomplished. But even if it is granted that the vessels actually do dilate after the injection of atropine, it does not follow that there is necessarily a better blood supply (*Durchblutung*) in consequence, as there may be, synchronous with the dilation, a slowing of the blood current, so that the final effect is not definitely secured. The low systemic blood pressure prevents the flow of blood through the dilated vessels with sufficient rapidity to bring to the tissues the copious amount of necessary oxygen.

But as injections of atropine, as we have demonstrated, increase the intraocular tension, they introduce a factor which is highly deleterious for the effective blood supply to the tissues, and this explains the failure of this therapeutic procedure in so many cases. To sum up, as a preliminary to any specific antisyphilitic treatment, the systemic blood pressure, and if possible the local retinal blood pressure in relation to intraocular tension, should be determined and checked from time to time. If one can prevent a lowering of blood pressure, one can hold off the atrophy of the optic nerve. This is a fact of practical importance not only for the oculist but for all physicians treating syphilis. Specific treatment in the presence of atrophy of the optic nerve is permissible only when the necessary stress (*Spannung*) has been established between intraocular tension and diastolic pressure in the retinal arteries. It is then not only harmless but defintely beneficial to the patient. The therapeutic production and maintenance of the aforementioned stress is to be striven for in all cases in which it is lowered. Not all cases of atrophy of the optic nerve are suited to this treatment, as the required conditions mentioned previously are lacking. One must individualize. A skeptical attitude toward these data is expected, but considering their great practical importance it is to be hoped many colleagues will check up these findings and procedures impartially, with careful consideration of the basic idea. The possibility of combating a widespread source of blindness and thus lowering the number of the blind not only presents a grave medical problem but is invaluable from the social-economic standpoint.

MEASUREMENT OF BLOOD PRESSURE IN THE RETINAL VESSELS; POSSIBLE SOURCES OF ERROR. PROF. HANS LAUBER, Warsaw, Poland.

Observers disagree as to the figures for the physiologic norm for the blood pressure in the retinal vessels. This depends partly on the

clinical material used in the research. Duverger and Barré, for example, used mainly sick subjects, so that their findings cannot serve as a criterion for average physiologic conditions. Even Bailliart has given different figures at one time or another, but he finally held to rather low values: diastolic retinal arterial pressure, from 30 to 35 mm. of mercury; systolic pressure, 65 to 70 mm. of mercury. The relation to the pressure in the brachial artery is as 40: 100 (Bailliart and Magitot). In youthful subjects with high blood pressure within the physiologic limits (70 mm. of mercury in the brachial artery) this would represent a retinal blood pressure of 28 mm., which would be insufficient for the blood supply of the retinal tissues. Suganuma's figures, which are higher than those of Bailliart, show that the systemic pressure is strikingly low. This may be a racial peculiarity of the Japanese. Bliedung, too, gives higher figures, but he used a completely different method for the determination. For subjects up to 50 years of age, Sobański gives the diastolic pressure as 40 mm. of mercury and the systolic pressure as 68 mm. For those over 50, the figures are from 48 to 56 mm. and from 80 to 90 mm. of mercury respectively, in the retinal vessels. The result of the study depends largely on the decision as to what moment the diastolic phase begins. According to the internist, diastolic pressure should be measured when there is a definite change in the caliber of the vessel; the systolic pressure should be measured when there is complete interruption of the blood current. This is advisable and justified practically as well as theoretically. The diastolic arterial pressure is the more important in retinal conditions. There is normally a difference of over 20 mm. of mercury between the diastolic arterial pressure and the intraocular tension. If this spread between the two pressure levels diminishes, the circulation in the retinal capillaries suffers. This first affects the conductivity of the fibers and finally causes their atrophy. It is immaterial whether this is due to increased intraocular tension, as in cases of glaucoma, or to lowering of blood pressure, as in cases of atrophy of the optic nerve and of retinitis pigmentosa.

HEIGHT OF BLOOD PRESSURE IN THE CHOROIDAL VESSELS OF MAN: DEMONSTRATION. PROF. E. SEIDEL, Jena.

In albinotic eyes the blood pressure in the vorticose veins can be measured easily by the well known and simple method applied to the retinal vessels. The slightest pressure on the eyeball, which, as is well known, brings about immediately a collapse of the retinal veins of the disk, is seen to be accompanied by a narrowing of the sinuses of the vorticose veins. This proves that the slightly increased intraocular tension is sufficient to embarrass the circulation in the vorticose veins or, in other words, that this tension already exceeds the blood pressure normally present in these veins. This phenomenon is particularly striking in albinotic subjects who present in addition to the usual 4 large vorticose veins a number of smaller ones (up to 6), which also emerge from the eyeball at the equator. These collapse completely when the slightest pressure is exerted on the eyeball, acting in this respect exactly like the veins of the papilla. This proves that the pressure is the same in the retinal veins and in the vorticose veins and only slightly higher than the intraocular tension. Combined measurements with the tonometer and the dynamometer show that even so slight an increase

in tension as 5 mm. of mercury is sufficient to overcome this pressure and cause a collapse of the smaller vorticose veins, which have about the same caliber as the veins of the disk. These phenomena were demonstrated in an albinotic subject aged 16. A number of important conclusions are drawn concerning the physiologic significance of this venous pressure. For one thing, under normal conditions replacement of the aqueous cannot be brought about by physical filtration (Leber) but is caused only by vital cell activity, i. e., primary secretion.

HISTOPATHOLOGIC PICTURE OF THE EYE IN ASSOCIATION WITH CHANGES IN THE KIDNEYS AND IN THE BLOOD PRESSURE. PROF. HUGO GASTEIGER, Frankfort on the Main.

The many varying views as to the pathogenesis of so-called albuminuric retinitis were the occasion for a study of 6 patients with this condition. The clinical diagnoses were chronic interstitial nephritis (*maligne Nephrosklerose*), chronic nephritis and in 1 case hydronephrosis, with subsequent nephritis and a fatal termination due to uremia. The ages of the patients were between 17 and 38. Fatty degeneration of the arterioles of the optic nerve and of the retinal vessels was found. There were accumulations of lipoids in the region of the posterior pole, and in 1 case these accumulations were also found in the periphery. They were most abundant in the internuclear layer and the nerve fiber layer, although scattered drops could be found in other layers, and accumulations were observed here and there in Müller's supporting fibers. The fat corpuscle cells were undoubtedly of glial origin for the greater part. Between the pigment epithelium and the retinal layers, leukocytes which had wandered in from the choroid were found in a state of fatty degeneration. Doubly refracting fats were found here and there and also varicose hypertrophy of the nerve fibers, edema, fiber basket (*Faserkorb*) formations and hemorrhages. The pigment layer showed no pathologic changes of note. Fat was demonstrated by the sudan stain only in the neighborhood of the disk in some eyes and there was some formation of warty nodules in this area and in the lamina vitrea. In the choroid fat was found in the vessel walls and in the stroma. Mainly in the region of the posterior pole but also in the periphery, the vessels showed a high degree of thickening of the walls, partly due to proliferation of the intima but principally to thickening of the muscular coat. Similar changes were found in the vessels of the ciliary body and processes. In the iris they had led in some places to complete occlusion of a vessel. The pathologic process was identical with that found in the small vessels of the kidney. Finally, in 1 case the sudan stain showed the presence of fat in Descemet's and in Bowman's membrane, in the corneal lamellae and in the leukocytes in the neighborhood of the limbus. There was no evidence of any external disease of the eye. The changes were undoubtedly connected with the underlying condition and due to a disturbance of circulation. When changes take place in blood pressure and in the kidney, the entire circulatory system of the eye suffers accordingly. At first the impairment is only functional; changes in the vessels cannot be demonstrated histologically until later. But even in the early stages, retinal lesions can be found. The predisposition of this structure, and especially of the macula, to pathologic changes under these conditions

is best explained, as Schieck has done, by the discrepancy between a comparatively meager blood supply and a high nutritional demand. Inflammatory changes play only a minor role in the disease picture, certainly not a decisive one. Koyanagi's well known view is not supported by these findings. There is no causal relation between retinal and choroidal lesions. They are associated results of a common pathogenic factor.

DISCUSSION ON PAPERS BY PROFESSORS BAURMANN, LAUBER, SEIDEL AND GASTEIGER

DR. ARRUGA, Barcelona, Spain: Although one is necessarily skeptical about all therapeutic suggestions for atrophy of the optic nerves, I treat my patients according to Professor Lauber's method because I consider it harmless and also because I was impressed by the unfavorable clinical course in cases of glaucoma simplex in which the blood pressure was low. All patients with atrophy of the optic nerve have low blood pressure, and the results of treatment are good if one can raise it and/or lower intraocular tension. The first factor is the more effective, although at times difficult to establish. In addition, I have used pilocarpine locally, performed cyclodialysis and prescribed good nourishment, tonics, strychnine, atropine, an ephedrine preparation, sun baths, mountain climate and travel. Persons with nontabetic atrophy were not benefited; however, all had normal or high blood pressure before treatment.

PROF. H. LAUBER, Warsaw, Poland: My associates and I laid great weight on early surgical intervention on account of the peculiarity of our clinical material. We could not keep the patients under treatment as long as was necessary for any material influencing of the circulatory condition. Accordingly, the intraocular tension was chosen as the point to attack. Retrobulbar injections of atropine may dilate the retinal vessels, but as they also raise the intraocular tension the good effect is neutralized, to say the least. The hematic nutrition of the retina certainly cannot be improved by this means.

PROF. E. SEIDEL, Jena: I have been misunderstood. I no longer measure blood pressure in the so-called abnormal, or posterior, vorticose veins which go through the sclera between the disk and the macula. My communication was based on observations on the vorticose veins proper, which enter the sclera from the choroid, close behind the equator, as from four to six larger vessels, accompanied by a varying number, generally from one to six, smaller ones (Leber and Fuchs). As mentioned previously, both sets of veins, like the central retinal vein, collapse completely on minimal digital pressure on the eyeball and are quite empty of blood, so that the pressure in these vessels can be only a few millimeters of mercury higher than the intraocular tension. The absolute height of the blood pressure in the retinal arteries will play an important role in the future (Lauber). I have repeatedly called attention to the fact that this figure (both for diastolic and for systolic pressure in the retinal arteries) depends greatly on the speed with which intraocular tension is raised by compression. This immeditely explains the discrepancy in the values obtained by various writers for normal subjects with the procedure of Bailliart. The immediate effect of digital compression on the eyeball is to obstruct the flow of blood in the central retinal artery until the blood pressure in that vessel may be raised almost to the

level of that in the ophthalmic artery at the point where the central retinal artery leaves it. A vessel 2 mm. in diameter has a blood pressure approximately equal to the systemic blood pressure (*Poiseuille*). This stasis-error can be eliminated, or rather reduced to its lowest possible minimum, only by a rapid increase in the compressive force. With a slow increase one always obtains figures which are decidedly too high. This holds good for the diastolic pressure which is present at the moment of the first large pulsation as well as at the time of complete collapse of the vessel. It also applies to the systolic pressure, which is reached when the compression is attained which keeps the vascular tube free from blood, not constantly but only during several cardiac periods. The only correct figures are the lowest which can be obtained after careful training and long experience with this method. In a case in which the general blood pressure was 120 mm. of mercury I obtained exactly the same values as Bailliart, that is, for the diastolic pressure 35 mm. of mercury and for the systolic pressure values of from 55 to 60 mm. of mercury, when I (as was done by Bailliart before he made use of the gage curve mentioned by Baurmann, planned from observations on the eyes of cats) subsequently measured with the dynamometer and the Schiötz tonometer, using Schiötz' gage curve II, the intraocular tension which had been artificially induced by compression.

HYALINE DEGENERATION OF THE LAMINA VITREA. DR. WALTHER REICHLING, Berlin.

Only definite hyaline structures were considered in this study. In some cases they were so numerous that one might speak of a miliary hyalinosis of the lamina vitrea. In many microscopic sections from 200 to 300 drusen of varying dimensions were counted. Between these nodules the entire lamina vitrea had undergone hyaline degeneration, with a smooth surface. Similar hyaline degeneration was found in the membrana elastica interna of larger choroidal vessels, corresponding in morphologic structure and staining qualities to senile drusen. This is actually an arteriolar sclerosis. The basal lamina in the chorio-capillaris also showed hyaline changes. All this demonstrates clearly that drusen are not an isolated disease of the lamina vitrea but part of a degenerative process affecting the entire system of limiting membranes between the choroid and the retina. In many cases these lesions cause no appreciable clinical symptoms, but the pathogenic factor may be of importance, as hyaline changes are noted in eyeballs affected by such different processes as phthisis bulbi and secondary glaucoma.

DISCUSSION

DOCENT DR. MAX BÜCKLERS, Tübingen: Dr. Reichling drew conclusions as to differences in the histologic structure of drusen from their reaction to Mallory's stain. For twelve years I have been using Heidenhain's azan stain, which is an improvement on the Mallory stain, and have been able by means of it to see the beautiful colors, ranging from violet and blue to red, in the cortex of the lens. However, a warning should be sounded against drawing too far reaching conclusions as to histologic and, above all, physicochemical composition from such varying reactions to staining methods. Von Möllendorff's studies have shown that the histologic staining process is an exceedingly complicated

one and that a number of different factors are involved. Hence one cannot draw conclusions as to the identity of a composition on the basis of similar staining reactions or, on the other hand, on the basis of dissimilar staining reactions.

DR. WALTHER REICHLING, Berlin: I agree that the result of Mallory staining should be interpreted with caution, but my conclusions were based also on other data in regard to form and structure of the lesions.

NATURE OF THE PROWAZEK BODIES AND OTHER INCLUSION BODIES. PROF. WILHELM GRÜTER, Marburg.

The nature of such bodies, e. g., the structures found in cases of bacteria-free blenorrhoea neonatorum, is still obscure. Experience gained in the study of inanimate cell poisons with varied staining methods, including osmic acid, were put to appropriate use in this research. Vaccinia keratitis in the rabbit presents a particularly well defined picture of focal inflammation of the Golgi system. This appears at both poles of the nucleus as a three-dimensional structure, with a Golgi body in a corresponding stage of cell division, there being one or more structures larger than cocci, and stains deeply black with osmic acid. A similar picture is presented by herpetic keratitis in the rabbit, but here the acute inflammatory reaction of the corneal epithelium induces an unusually intense swelling (*Blaehung*) and proliferation of the entire Golgi framework. The little Golgi bodies, although they have multiplied greatly, can hardly be seen, as they are hidden in the fine meshes of the densely proliferating network of the whole Golgi zone. Dark field examination of the hanging drop culture shows that the deeply stained corpuscles are actually glass clear, round or oval, homogeneous vacuoles, which glitter in the light of the dark field. They have a definite fine polar formation in the form of minute secondary superimposed vesicles. These secondary vacuoles are cast off later, and the primary forms break down also. The vacuoles, either singly or in moruloid formation, appear in lesions produced by animate and inanimate cell poisons, staphylococcus toxin, diphtheria toxin and oil of mustard. The specimens studied were checked repeatedly as to freedom from bacteria. The Prowazek bodies of trachoma are simply the spherical Golgi bodies which have increased in size by cell division under the stimulus of inflammation. In the entire course of the trachomatous process no structures were found which in any way suggested parastic organisms, nor were there any unusual inclusion products of inflammation, such as the hypothetic chlamydozoan (Prowazek), either in the nucleus or in the cytoplasm.

DISCUSSION

PROF. KARL LINDNER, Vienna: Conclusions as to the nature of trachoma bodies are possible only if these structures are studied in all their phases, either in a fresh moist smear or in sections. In a dried smear the inclusion body is like a shriveled jelly fish which gives no inkling of its actual original form. The analogy advanced by Grüter is incorrect. In America Thygeson has published a series of articles dealing with the inclusion virus which in every respect confirm my own findings. This investigation started from the observation of inclusion-bodies in cases of psittacosis which are morphologically almost identical with the free initial bodies of trachoma.

PROF. H. HERZOG, Berlin: It is an open question whether the cell inclusion bodies described by Grüter correspond to the inner network (*Binnennetz*) of Golgi. But it is impossible to subscribe to his interpretation that the essential and basic histologic factor in the pathogenesis of trachoma is presented by the structures which he found in the cytoplasm. At all events, it is necessary to oppose energetically the misunderstanding which has arisen in this connection. Since Prowazek's observations the essential factor has not been considered the so-called trachoma bodies in any case but rather the individual corpuscular elements which composed them, i. e., the elementary organisms of varying size, down to the ultramicroscopic (*subvisiblen*), which are found scattered singly or in twos in the epithelial cell or enclosed in larger zooglea-like groupings. It is out of the question that any of the original structures found by Prowazek were normal formations, products of biologic metabolism, structures due to secretory functions (*Sekretgranula*) or an expression of the decomposition of ageing or diseased protoplasm. I have been able to produce these inclusion bodies experimentally by inoculation of pure cultures of gonococci into the healthy human conjunctiva of a blind eye which has been voluntarily placed at my disposal. There are many other inclusion bodies, as I have pointed out previously, such as secretion granules, Ballowitz' baskets, idiosomes, mitochondria and trophoplasts, which complicate extraordinarily the problem of trachomatous infection in the epithelial cell. Trachoma is not of a herpes nature. Progress in the study of this problem requires that one take into consideration data of a recent investigation in bacteriology concerning the life cycle of microorganisms which was based on research into their variability as to morphologic and biologic activity.

PROF. WALTER LOHLEIN, Berlin: I should like to ask Professor Grüter whether he considers the structures made visible so beautifully, particularly in the dark field, and which without prejudice and provisionally he has called "vacuoles," to be the cause of disease or animate structures at all. Does he assume that these vacuoles, in which he speaks of budding (*Sprossung*) and reduplication (*Vierteilung*), actually have a structure, which I have so far been unable to detect, or does he, perhaps, infer that they are formations called into being by an exceedingly minute self-contained activating body (*Erreger*)?

PROF. WILHELM GRÜTER, Marburg: The Golgi vacuoles described by me are identical with Lindner's initial corpuscles, but I cannot say whether they are the actual carriers of trachoma. In the dark field they are uniformly homogeneous. A finer inner structure different from the minute secondary changes at the poles (*Polungen*) could not be made out. After these structures have been allowed to develop for several days in the inflamed epithelial cell, they are generally larger than cocci and so cannot be the pathogenic factor of trachoma, which at the present time is generally assumed to be a filtrable virus.

CHANGES IN THE NERVE STRUCTURES OF THE CORNEA AFTER EXTIRPATION OF THE GASSERIAN GANGLION. K. A. REISER, Bonn.

About thirty hours after extirpation of the gasserian ganglion the first signs of degeneration of the corneal nerves appear. After sixty

hours hardly a single fiber of the thick corneal nerve bundles is intact. Some nerve fibers have coalesced to clumpy strands, in which more or less numerous vacuoles are seen, depending on the degree of degeneration. Other fibers break down into rows of fine granules or into segments. The signs of degeneration lessen gradually toward the periphery of the nerve elements. In so-called preterminal network there is only a delicate thickening of the nerve fibers. The terminal reticulum shows no signs whatever of degeneration. This power of resistance is due to the syncytial structure and has been known for some time. The few fibers which enter the cornea from the conjunctiva suffice to provide the nerve supply to the corneal cells by way of the terminal reticulum, which has remained intact after section of the afferent nerves. These histologic data also explain why after radical extirpation of the gasserian ganglion, as opposed to injection of alcohol, neuroparalytic keratitis rarely ensues.

DISCUSSION

PROFESSOR ENGELKING, Heidelberg: I should like to know about the extent of Reiser's experimental material and whether his results were uniform.

K. A. REISER, Bonn: Fifteen eyes were examined. Involvement of the trigeminal nerve is probably not responsible for neuroparalytic keratitis. This condition does not occur after destruction of the nuclear region (*Kerngebiet*) of the trigeminal nerve and can, accordingly, be caused only by nerve filaments which join this nerve in its course and which when pathologically altered in any way bring on a corneal inflammation.

RETINAL DETACHMENT. PROF. W. MEISNER, Cologne.

The relative frequency of retinal detachment in cases of myopia, on the one hand, and in cases of emmetropia and of hyperopia, on the other hand, is considered. In the latter, the frequency does not rise markedly until after the patient is in the fifties. At an earlier age it is almost always possible to detect pathologic changes in the vitreous, retina or uveal tract. Since detachment in cases of myopia of low degree is seen predominantly in elderly persons and since high degrees of myopia are decidedly less numerous than the lower degrees, the increasing hazard associated with the advance of myopia becomes apparent.

TRUE RETINAL CYSTS AND RETINAL DETACHMENTS. DR. ERNST CUSTODIS, Düsseldorf.

In a patient aged 30 there were grouped about the disk, about half way to the ora serrata, five large cysts, of from 3 to 5 papilla diameters, and on the temporal side, somewhat nearer the ora serrata, two smaller cysts, of from 2 to 3 papilla diameters. There were no cysts below the disk but a somewhat more protruding detachment. The Gullstrand instrument showed that these cysts were located in the middle, inner nuclear and outer plexiform layers of the retina, dividing it into two layers and protruding into the vitreous and also toward and against the wall of the globe. No tears were detected. Histologic examination con-

firmed the clinical findings, except for the fact that some small cysts had been overlooked. The content of the cysts was generally clear. Smaller ones contained markedly hypertrophic Müller supporting fibers. The wall of the cyst showed a marked disappearance of cells and complete absence of sensory elements. There were defects in the external limiting membrane. The pathologic changes were probably connected with the nutrition of the retina. As a cause of pathologic changes in the supporting tissue of the retina, clinical experience has indicated vascular disturbances, blunt injury and detachment. In some cases there may be a congenital inferiority, structural or biologic, of the glial substance. This need not affect the entire retina. That it may be present only in certain limited regions is proved by the observation of tears at the orra serrata and the formation of cysts in cases of detachment below and outward in juvenile subjects.

RETINAL DETACHMENT AND TRAUMA. PROF. E. KRÜCKMANN, Berlin.

Injuries acting indirectly to produce retinal detachment if the following triad is present are discussed: (1) abdominal pressure; (2) congestion, cerebral and intraocular, and (3) a swelling in the retina similar to that in the brain. A porter stated that when the sack he was carrying suddenly slipped he became frightened and clutched the sac, holding it with one arm while he tried to lift it up with the other arm. The retina was torn loose at the end of the ora serrata. The explanation for the detachment was sought in the sudden and intensive action of the inferior oblique muscle associated with the quick upward glance while the patient was in a crouching position. The inferior oblique muscle exerted a suction action on the sclera, which had been made tense by retinal swelling, conceived as a swelling in the brain in this case, and caused the retina to tear loose at its anterior end. A number of other conditions are considered which could lead to tears at the ora serrata.

DISCUSSION ON PAPERS BY PROFESSOR MEISNER, DR. CUSTODIS AND PROFESSOR KRÜCKMANN

PROF. WALTER LÖHLEIN, Berlin: Such clinical surveys of a large amount of material are valuable and enable one to eliminate a number of factors of error. There appears to be no uniform single cause for retinal detachment, even if one considers only the myopic form. An etiologic and genetic subdivision will give data for or against the choice of this or that operative procedure. Professor Meisner's figures confirm the impression that a moderate degree of myopia presents as great a hazard for detachment as a high degree. Possibly in the cases of myopia of extreme degree degenerative changes in the fundus are unusually extensive, causing wide areas of scar fixation which tend to counteract detachment.

PROF. KARL LINDNER, Vienna: It is the rapid snatching motion of the eye which causes the tear, but the direct effect is due to the vitreous, which has become detached. Like all elastic bodies, it stretches to the limit and then snaps back. The stretching is due to the lag of the vitreous masses based on inertia of sudden movements of the eyeball.

This is the mechanism of shock to the vitreous body which may cause the degenerated retina to tear, particularly at exposed points of attachment of the vitreous. Such shock generally affects the upper half of the retina when the eye instinctively and suddenly glances upward. The flap tear then remains attached to the separated vitreous. One must admit that the injury is the exciting cause. Except for it, a detachment might never take place, as the vitreous in the course of years loses mass, and with it dynamic energy, either through shrinkage or as a result of central fluidification. In penetrating injuries, on the other hand, it is hemorrhage into the vitreous which becomes organized and detaches the injured retina and so leads in the course of time to detachment of a small part of the choroid. Intraocular fluid is now absorbed by the choroid; the compensatory replacement of the aqueous causes a further contraction of the rest of the transparent vitreous. The same process is involved in the formation of cystic holes in the macula. Those who attribute the development of a retinal defect to retinal degeneration, pure and simple, should choose some other designation for the term "flap tear."

PROFESSOR BARTELS, Dortmund: I am inclined to believe that the cystic degeneration is often located, at its incipiency, in the outer plexiform layer, particularly external to the fiber layer of Henle. There seems to be a contradiction in the fact that tears in the region of the superior oblique muscle are almost always tongue shaped while those in the lower segment are disinsertions at the ora serrata. If the inferior oblique muscle plays a part here, the difference in the form of the tears is not easy to explain. The superior oblique muscle would seem to be the stronger of the two muscles.

PROFESSOR PILLAT, Graz: It would be well to drop figures of the degree of the myopia from consideration in the statistics of detachment and to judge the character of the error of refraction from the standpoint of the presence or absence of degenerative changes. For similar reasons, perforating injuries should be excluded or at least considered separately in statistical studies, in order to lay stress on the effect of contusion. This factor has a particularly dire influence on biologically inferior eyes, and it is in these that it generally causes detachment. The case of a young Mongol is related who was thrown from his saddle, and dragged by the stirrup and whose head was struck repeatedly against the ground. There was a bilateral detachment of the retina with several slit tears, with eventual complete restoration of vision in one eye. In the other eye hemorrhage into the vitreous became organized and led to blindness.

DR. ERNST CUSTODIS, Düsseldorf: As a result of pathologic changes in the glia, the retina loses some of its resistance to mechanical injury and also some of its toughness. Accordingly, in the case under discussion it is possible that the retinal tear and/or disinsertion at the ora serrata were caused by traction on the part of the vitreous, but the tear was made possible only by the fact that disease of the glia caused the retina to tear easily. Repeated examinations have shown me that the vacuoles are found near or in the inner nuclear and outer plexiform layer rather than in the outer nuclear layer.

LIMITS OF NATUROPATHY IN THE TREATMENT OF OCULAR DISEASES. PROF. KARL VOM HOFE, Greifswald.

The living organism has the faculty of overcoming various diseases without extraneous aid. Nature's method of cure can be aided without medication by the application of natural stimuli. It follows that only those diseases of the eye which are susceptible to spontaneous cure can be safely subjected to these measures. This is generally the case with the majority of acute inflammations of the conjunctiva, iris and choroid. Cure may take some time. There are exceptions enough, especially such ocular pathologic processes as inflammation due to the diplobacillus, ulcus serpens and many others. At any rate, acute inflammations of the conjunctiva, which experience has taught heal spontaneously, should generally not be treated with medication the action of which is not sufficiently known and which under certain conditions may do damage or interfere with the healing processes of nature. Blennorrhea neonatorum and adultorum are examples. Repeated and copious irrigations do not cause the gonococci to disappear. In fact, they are found in the conjunctival sac after all clinical symptoms have ceased. If the irrigations are kept up during the night, the patient is deprived of sleep, and thus his resistance to infection is impaired. Pus should be gently wiped away from the lid fissure and irrigations should be reduced to the minimum, even in the presence of corneal infiltration. I have used this gentle method for a long time and have not lost a single eye. In cases of scrofulosis (phlyctenular keratitis?) also, all too frequent local medication aggravates the blepharospasm, which is a protective reaction. It can hardly be questioned that climatic and dietary treatment of ocular tuberculosis, especially of the sluggish forms, brings about better results than injections of tuberculin. Chronic inflammatory conditions get well promptly if they are left alone, even the postoperative conditions as well as true hypersensitivity to drugs, which is frequent enough and often overlooked. Patients treated in the clinic for months without success get well promptly when hospitalized. The change in the entire surroundings plays a part, as it does when conditions are reversed. It is always futile to continue with any form of active treatment for months. If it is efficacious, it should act at once. All this implies experience and judgment. The latest handbook of naturopathy, by Brauchle, which is also intended for the educated layman, has a section on the treatment of ocular diseases, including hordeolum, trachoma, interstitial keratitis, herpes zoster (*Gürtelrose*), chalazion, conjunctivitis, ulcus serpens, "scrofulous" blepharitis and iritis. The treatment, obviously invariably successful, is practically the same in all cases, viz., steaming the eye with chamomile tea, eye baths, poultices and raw diets. Such measures will not cure a true progressive ulcus serpens, and most hordeola and inflammations of the conjunctiva get well without "alternating hot and cold douches, foot baths, sitz baths, raw diet, etc." Diplobacillary conjunctivitis, for instance can be cured more rapidly and cheaply with zinc preparations and staining solutions. For diseases which offer no prospect whatever of recovery, such as embolism of the central retinal artery and retinitis pigmentosa, Brauchle advises visual exercises after the manner of Bates. They do no harm. True, they do no good either. For retinal detachment, Brauchle advises "exercises to lower tension, suggestive therapy." For decades this particular con-

dition has been treated for years at a time and in every possible way without success and has not been affected by general treatment of any kind. Failure to perform a timely operation, which is successful in from 50 to 60 per cent of the cases, is in most cases a grievous error which cannot be rectified, and it is seen, in this condition particularly, how a dogmatically maintained and one-sided point of view may work out to the damage of the patient. Brauchle says that glaucoma may lead to blindness if it is not attacked by "general treatment and a complete change in the entire way of living." He also advises the laying on of hands (on the eyes) and "certain ocular motions (sweeping and swinging, according to Bates). If the attack is acute the body and/or legs are to be wrapped up and baths and a fruit diet prescribed. Much work has been done on glaucoma in the last few years, and any physician who has had much clinical experience with this disease, whether untreated or treated by naturopathy, has learned that glaucoma is never affected spontaneously or by general treatment for any length of time. Unless treated locally, glaucomatous eyes are doomed to blindness. However trivial these remarks may sound, Brauchle's statements make it imperative for one to point out one's own experience openly and frankly and in the interest of the health of the community and to warn most insistently against his way of treating glaucoma. Warts can be cured by suggestion, and so can eczema of the lids at times. Years ago, together with Krantz, I experimented with simulated radiotherapy in cases of chronic eczema of the lids. But to treat glaucoma or retinal detachment suggestively without medication or/and surgical measures would be a grave error. In cases of glaucoma in which systemic indications made it necessary to put the patient on a diet free from meat and salt, I have never been able to see any effect on the increased intraocular tension from such measures alone. The same negative results followed the use of foot baths of all sorts, wet packs and similar measures in cases of simple glaucoma. Scheerer's clinical experience tallies with mine. Natural healing must be avoided and replaced when it does harm.

SPECIFIC OR NATURAL TREATMENT FOR OCULAR TUBERCULOSIS? PROF. W. WEGNER, Freiburg.

Clinical experience in Höchenschwand Institute in the Black Forest with about 500 patients with ocular tuberculosis, one third of whom had previously had specific treatment, proved that these measures were rarely carried out systematically, persistently or in a way to satisfy the theoretical requirements. Most of the patients had not received more than a few injections of tuberculin, and those rather irregularly. Small doses were the rule. When large doses were given, unmistakable damage resulted in a number of cases, especially after inoculations according to the method of Pondorf. Treatment of an ambulatory patient with tuberculin is absolutely contraindicated, as its results are incalculable. Dietetic treatment at a sanatorium at a moderate altitude (*Mittelgebirge*) makes any and all specific treatment superfluous and offers the best prospects possible in cases of ocular tuberculosis.

IN WHAT WAY CAN NONSPECIFIC STIMULATION THERAPY INFLUENCE ALLERGIC CONDITIONS? DR. PROF. WOLFGANG RIEHM, Giesen.

The purpose of this therapy is to increase the efficacy of certain organic functions concerned in overcoming chronic infections. The

stronger the stimulus, the longer the period of latency which precedes any good effect. In this antecedent phase of aggravation (*Mehrbelastung*) and inhibition of function, however, lies the hazard of this method. The activity of the antibodies is not increased until later, but it is a mistake to judge their effect by the ease or the difficulty with which phenomena of hypersensitivity are produced. These phenomena do not by any means denote an increase in the antibodies. On the contrary, sensitization may increase when there has been a loss of cast-off humoral antibodies which protect the cell from the cellular reaction, i. e., the anaphylactic reaction. If the initial phase of deallergization is provoked too intensely and continued too long, the bacteria take advantage of this by a rapid increase in number and toxicity. The bacterial reaction depends on the degree of allergization, because in so-called bacterial allergy the corresponding antibody fulfils a function which is closely associated with the protective mechanisms of the organism in striving to overcome the pathogenic factor (*Erreger*). As bacterial protein and antibodies are antagonistic, antibodies thrown off and free in the circulation must be dangerous to individual bacteria. The antibodies in an allergic state (antianaphylactogens) are in all probability identical with certain bacteriolysins.

DISCUSSION ON PAPERS BY PROFESSORS VOM HOFE AND WEGNER AND DR. PROFESSOR RIEHM

DR. REINHARD BRAUN, HABIL., Rostock: Tuberculin treatment of ocular disease must be condemned in toto. In some cases it has done much harm; in others it is justified, particularly in cases of sclerosing keratitis and of scleritis. Focal reaction to the treatment can be seen with the slit lamp, and in a case under observation at this moment I have noted a definite limitation of the process. It is a matter of course that the general condition be kept under the most careful observation by periodical physical examinations, even during the period of treatment. Even after a cure there should be a therapeutic follow-up study for months and years.

PROF. BRUNO FLEISCHER, Erlangen: I have had good results with various tuberculin preparations in the course of many years and especially with tebeprotin (Toenniessen). Great precaution is, of course, essential in the use of all these preparations. I aim to give the smallest amount possible consistent with a positive, even slight reaction. Specific treatment is aided by clinical therapy with fresh air, rest and good nutrition.

PROF. RICHARD SCHEERER, Stuttgart: I consider it of basic importance and absolutely essential that the procedures of naturopathy be objectively and carefully tested by ophthalmologists.

PROF. KARL VOM HOFE, Greifswald: In the last analysis it is nature that cures. One can aid natural processes only when they are present in some form, i. e., in diseases which experience shows often heal of their own accord. There is no such natural cure for glaucoma. Medication and surgical intervention can, however, do away at once with the most dangerous symptom, increased tension, which is the factor leading to blindness in practically all the cases.

(To Be Concluded)

Book Reviews

Eyestrain and Convergence. By N. A. Stutterheim, M.D. Price, 7s. 6d. Pp. 89, with 2 illustrations and 3 tables. London: H. K. Lewis & Co., Ltd., 1937.

In this short monograph the author states that the true primary position of the eyes is one of divergence, the extrinsic muscles acting as tensors and not antagonistically. In his opinion, convergence represents an autonomic power of the mind (or brain), which acts by visual reflexes only and not through volition or with the assistance of consciousness. During vision this convergence keeps the muscles of convergence (all the extrinsic muscles of the eye except the external rectus muscles) in constant action. Convergence acts as much through inhibition of its muscles as through their contractions (Sherrington). The complete development of converging power is necessary for man's visual efficiency in modern civilization. If this power is not fully unfolded, eyestrain results. This eyestrain is curable by kinetic treatment, which is designed to develop the power of convergence.

Stutterheim agrees with Brouwer that Perlia's nucleus is the convergence center and that it exists only in the simians, presimians and felines, the only mammals having a fovea and approximately parallel visual axes. He also states that the highest development of the brain is not ocular function but rather binocular, bifoveal function, the kinetic principle of which is convergence. Fusion is the result rather than the cause of convergence. Just as accommodation is the kinetic part of monocular vision, so is convergence the kinetic portion of binocular vision. If convergence is absent, there is diplopia; if convergence is insufficient, eyestrain, or asthenoconvergence, results.

The author also discusses the innervation of the muscles of the eye and the relations between convergence and accommodation. Because convergence is a phylogenetically young reflex, it is likely to be insufficient.

In testing for asthenoconvergence, the patient sits 5 or 6 meters away from a black screen, which is 4 feet (120 cm.) square. The fixation object is a strip of white cardboard, 75 by 10 mm., which can be rotated to test for both horizontal and vertical convergence. There is a chin rest for the patient and a trial frame for holding single prisms. Successively stronger prisms are placed in front of the eyes until the double images of the white strip no longer fuse; the strongest prism with which fusion is attained is taken as the strength of convergence. The nominal range of convergence is approximately 50 degrees of prism, which is about two and one-half times the convergence used in ordinary reading. Stutterheim thinks that amblyopia, contracted fields and photophobia are uncommon but definite signs of asthenoconvergence and that visual acuity may improve after kinetic treatment.

In treating asthenoconvergence, Stutterheim uses a set of single prisms and two batteries of eight prisms, one ranging from 1 to 8 degrees, base at 180 degrees, and one varying from 0.25 to 2 degrees,

base at 90 degrees (the latter for vertical deviations). He first measures the heterophoria for distance with a Maddox double prism and a red glass before the two eyes and then measures the prism abduction and adduction. If the convergence is less than 50 degrees, it is considered to be insufficient, and convergence exercises with the prisms are given until the highest convergence possible (up to 84 degrees) is attained. If success is not attained with the fixation object at 6 meters, it can be brought nearer the patient. Approximately twenty-four sittings are required to cure asthenoconvergence, three of them being used for diagnosis.

The final table of the monograph gives the data for the first hundred patients treated by the author (more than a thousand patients have been so treated); all except six of these one hundred were relieved of their symptoms.

This reviewer will not attempt to criticize the author's theory of the action and innervation of the extrinsic muscles of the eye.

With regard to his treatment, it seems to have been very effective in his hands. It is a question whether all persons with convergence insufficiency need such prolonged and drastic exercises. In this country ophthalmologists are interested in measuring the convergence near point and the PcB (punctum convergens basalis); when they are remote, simple convergence exercises which are carried out at home by the patient often relieve symptoms.

Because Stuttenheim has devoted a great deal of time to the study of the extra-ocular muscles and because he has developed a routine treatment for aiding persons with convergence insufficiency, his monograph deserves to be read by those ophthalmologists who are particularly interested in cases of muscle unbalance.

W. F. DUGGAN.

Der psychische Restitutionseffekt. By Otto Löwenstein, M.D., formerly full Professor and Director of the Psychopathological Institute of the University of Bonn, and Directing Physician of the Rhine-Provincial Sanatorium for spiritually abnormal children in Bonn; at present in Nyon, Switzerland, La Métairie Clinic. Price, 8 francs (Swiss). Pp. 92. Basel: Benno Schwabe & Co., 1937.

In a previous publication reviewed by Ward Holden in the ARCHIVES (**15**: 365 [Feb.] 1936), the author discussed the disturbances of the pupillary light reflex in cases of syphilis of the central nervous system and showed how they could be distinguished from nonsyphilitic anomalies of this function. In the present work he devotes himself to an analysis and explanation of the psychically occasioned restitution of fatigued, exhausted or diseased function as it is expressed mainly in the pupillary reaction to light but also in the patellar tendon reflex. The effect of psychic stimulation, pleasant or unpleasant, on fatigued bodies is a well known phenomenon. The author calls attention to the influence of military music on tired marching troops. This has been rather cursorily attributed to a simple inhibition, whereas Löwenstein shows that it is a true phenomenon of defatigation (*Entmüdung*), affecting actual fatigue, and mainly of neurovegetative provenance. The physiologic nature of fatigue brings up problems of chronaxia,

parabiosis and other factors, which the author intends to discuss in a later publication. As shown in his earlier work, mentioned previously, "organic" destruction of the pupillary reflex, as found under pathologic conditions, for instance in many cases of syphilis of the central nervous system, shows a far reaching analogy with physiologic fatigue. The analogy relates not only to the clinical phenomena of the reaction but to the possibility of restitution by psychic stimuli.

The course of defatigation retraces, step by step and in regular, but reverse order, the phases, some seven in number, which modern graphic methods of registration demonstrate in the progress of fatigue, viz., by pupillography in the case of the eye and by a simple registering apparatus in the case of the patellar tendon reflex. For general biology, the *Restitutionseffekt* is of importance as an essential factor in the physiologic defatigation of organs supplied by the vegetative nervous system. In the pathologic field, this effect can be demonstrated as long as any remnant of function is preserved. The degree to which damaged function can be psychically restored shows how far it can be cured in spite of organic changes, and is, accordingly, of practical prognostic importance. If Löwenstein's earlier work gave "a method of exact physiologic measurement comparable to those of the perimeter and the tonometer," the present study is even more instructive and of wider bearing. It is significant that the author gives his title as former professor and director at the University of Bonn and directing physician of the Rhine-Provincial Sanatorium and that the work reviewed here comes from Switzerland and is published by a Swiss house.

Gegenseitige Auswertung der Augen-und Röentgensymptome bei der Tumordiagnostik im Sellabereich. By Dr. Willy Loepp, Königsberg. Price, 6.60 marks. Pp. 58, with 28 illustrations. Berlin: S. Karger, 1937.

The author of this book is director of the roentgenographic department of a hospital in Königsberg, and the book has been written with the assistance of the members of the staff of the ophthalmic clinic of the University of Königsberg.

Many tumors of the pituitary gland are slow in developing, and by the time the endocrine and vegetative disturbances become manifest the anatomic changes are so marked that treatment is unsatisfactory. An earlier diagnosis can be made by studying the disturbances of the optic nerves, with the exact localization of the retinal functions, and the bony changes in the sellar region. The pressure symptoms show the direction of growth and so suggest the site of origin. Examination of the visual fields is of the greatest importance and must be most carefully performed. Tumor of the hypophysis is no longer a sufficient diagnosis, but an exact diagnosis should be attempted. The knowledge concerning these tumors and related conditions permits the following classification: (1) tumor of the infundibular region, of the hypophysis, (2) tumor of the meninges, (3) tumor of the optic tracts and (4) aneurysm, hydrocephalus and similar conditions. The endocrine disturbances, the ocular changes (visual field, optic nerve and exophthalmos) and the value of roentgenographic findings are carefully

reviewed; the consideration of the last subject is the most valuable part of the monograph.

Twenty case histories, with a discussion, follow. Based on a study of 120 cases, the author makes the following conclusions: 1. Symptoms referable to the endocrine and vegetative system suggest a disturbance in the infundibular region of the hypophysis. 2. Careful examination of the optic paths and the bony skull should be made. 3. The changes revealed by such an examination are of value in their relation to one another. 4. The direction of growth is important. 5. A division of tumors according to their position in respect to the chiasm is desirable. 6. Examination of the visual fields is most important. 7. The form of enlargement of the sella turcica is also influenced by the size of the sphenoid sinus.

Twenty illustrations, showing the more important roentgenographic changes, are included.

ARNOLD KNAPP.

Zur Grundlegung der Blinden-Psychologie. By G. Révész, University of Amsterdam. Reprint of an Article in the Festschrift for Prof. Dr. Anathon Aall of the Kongelige Fredericks Universitet, Oslo, Norway. Pp. 12. Oslo, Norway: Det Mallingske Bogtrykkeri.

The mental and physical reactions of the blind to the outer world and those in it have always interested ophthalmologists from the practical side, as have the reeducation of those deprived of sight and their training in gainful occupations, trades and handicrafts. A classic contribution to the knowledge of what might be called the everyday psychology of the blind is, of course, Javal's "Entre aveugles." The work reviewed here considers matters from a more theoretic point of view and attempts to lay the foundation of a general psychology of blindness. The author, who is in charge of the psychologic laboratory at Amsterdam, has formulated what he considers the basic problems of this study as being to determine how the outer world is conceived and represented, respectively, by and to the mind of the sightless; what its structure is, and what characterizes the nature and origin of conceptual spatial forms. These are, of course, problems which refer to perceptual theory in general and, more particularly, to the study of the relations between the optical space world and that which is purely tactile, or, as the author styles it, haptic. This cognitive sense deals with space, objects and form. The history of this study and an analysis of the various "clinical" methods used in an attempt to fathom the workings of the minds of the blind are presented at length. This little work, which does not lend itself to abstracting or to a summary review, is instructive and will be read to advantage by those who are interested in the borderland topics of ophthalmology.

PERCY FRIDENBERG.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

International Ophthalmologic Congress

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. I.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

Midland Ophthalmological Society

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

Ophthalmological Society of Egypt

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.
Place: Memorial Ophthalmic Laboratory, Giza. Time: March 25, 1938.

Ophthalmological Society of the United Kingdom

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian Str. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.
Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTHALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arieh-Friedman, 96 Allenby Str., Tel-Aviv.
Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montrea
Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donoher, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501–7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown, Pa.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown, Pa. Time: May 19, 1938.

STATE

Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Place: New London. Time: February 1938.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. John King, Thomasville.
Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.
Place: Augusta. Time: May 1938.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. E. E. Holland, 51 S. 8th St., Richmond.
Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: April 6, 1938.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.
Place: New Orleans. Time: Spring, 1938.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.
Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.
Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.
Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221–5th St., Bismarck.
Secretary-Treasurer: Dr. F. L. Wicks, 514–6th St., Valley City.
Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165–8th Ave., N., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.
Place: Nashville. Time: April 12-13, 1938.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102—3d St., Troy, N. Y.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.
Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606-20th St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, O.
Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, O.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Ophthalmological Society of the University of Pittsburgh

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

Passaic-Bergen Ophthalmological Club

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.